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EPOCH-MAKING BOOKS IN BRITISH SURGERY.

BY SIR D'ARCY POWER, K.B.E., LONDON.

IX. THE WORKS OF PERCIVALL POTT.

THE writings of Percivall Pott exercised a very great influence upon surgery during the last half of the eighteenth century. They were read both at home and abroad, and his name is better known on the Continent than that of any other English surgeon except Lister—better even than that of John Hunter—by the rank and file who have no knowledge of the history of surgery. His recognition in England is due to several causes. He was a popular lecturer in London when a desire was arising for improved instruction in surgery. His lectures were open to all on payment of a small fee and were attended by large numbers. He often published his observations in the form of pamphlets at a cost of one shilling and sixpence, instead of in the heavy and expensive volumes of his predecessors. He wrote well and clearly from his own experience. His pamphlets, therefore, were interesting and could be read with pleasure and profit by those who were just awakening to a knowledge of their own ignorance. Mentally he was not much in advance of his time, for scientific surgery had not yet come into being, and he was essentially a clinical surgeon, who observed what he saw and taught his pupils to follow his example. For the most part he stood on the old ways and followed the old lines of treatment, but he straightened out and made plain the paths so that his followers walked along them more easily and were able to go further.

Pott, as is well known, did not begin to write until he was forty-two years old, and only then because he had broken his leg and wanted to employ his active mind during the tedium of convalescence. He then planned and partly executed his "Treatise on Ruptures," which was published in 1756 and was completed by his "Rupture in Infants" which appeared in 1765.

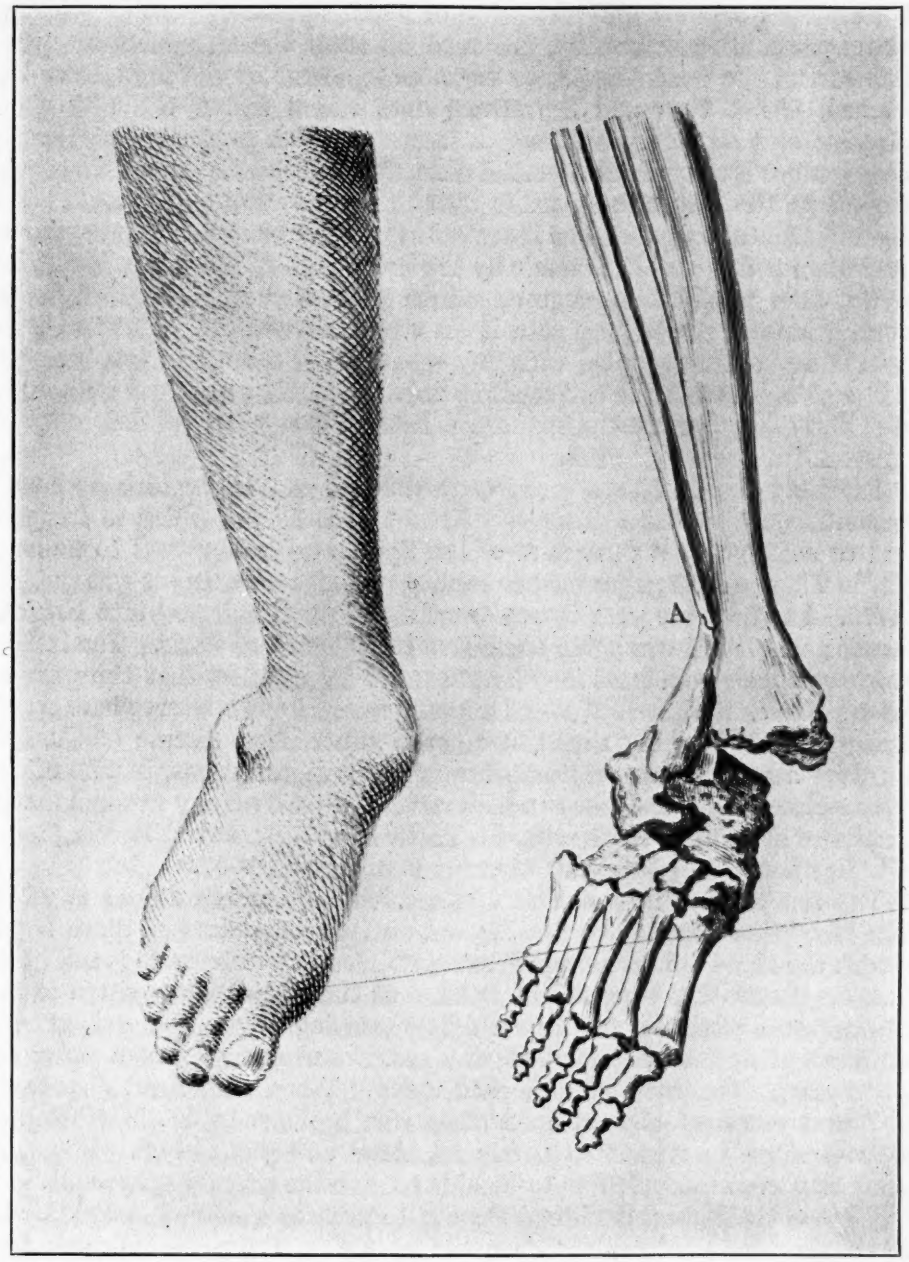
The opening sentences of the "Treatise on Ruptures" is still applicable, and the warning is as necessary now as when Pott wrote. He says: "The generality of mankind look upon a rupture as an imperfection in their form, as a disease which impairs their strength and lessens their generative faculty; which apprehensions, though absolutely groundless, are so firmly rooted in

the majority of those who are afflicted with the disorder as to make them not a little miserable. They who lie in wait to avail themselves of the weaknesses of the infirm and fearful, are well acquainted with these fears, and very lucrative use do they make of them; they well know that a man who regards his disorder as an imperfection in his form or as a cause of any debility, more particularly a venereal one, will be very unwilling to have it known, and as glad to get rid of it at any expence or trouble; by this means impostors are furnished with opportunities of subjecting the ignorant and credulous to tedious confinements, painful applications and even hazardous operations; and of defrauding the timorous and bashful of large sums of money for imaginary diseases and pretended cures.

"A rupture is a disease which, if judiciously and honestly treated from the first, can never be productive of much profit to a surgeon; it requires very little attendance and neither external application nor internal medicine; though the reduction of the gut and the application of a proper bandage are necessary, yet this is, in general, so soon and so easily accomplished that it must be obvious no great emolument can from thence be derived." This was written at a time when the family practitioner was paid for the plaster he applied and the bottles of physic he prescribed and never for the time taken or the advice given. The treatise is thoroughly practical, and did much to standardize the treatment both of reducible and strangulated hernia. Of reducible hernia he says: "Let the cause [course] of it be what it may, as it can never be absolutely foreseen it should never be trusted; the sooner a rupture is reduced, the sooner a patient is out of danger." Of strangulated hernia he advises: "If I might presume to give my opinion on the subject, I should say, that the operation ought always to be performed as soon as possible after it appears that all rational attempts, by large and free bleeding, the warm bath, glysters &c. are found to be ineffectual; or that the symptoms rather increase than decrease, while such means are made use of, and that the handling necessary for reduction becomes more and more painful."

The most important contribution to surgery made by Pott is "Some few Remarks upon Fractures and Dislocations", which he published in 1768. This pamphlet was written to abolish the use of instruments which had been employed to extend and counter-extend the fractured limb and to replace the old methods by keeping the muscles in a state of relaxation. It effected its purpose, and for several generations Pott's treatment of fractures was generally employed throughout England. The paper, too, gives a detailed account of that form of fracture and displacement at the ankle to which Pott's name is now universally attached. It was written some time after he had himself suffered from a similar injury, but he writes of it quite impersonally and makes no reference to his own experience. He points out that if the fracture is treated in the usual way by extension there is difficulty in reduction, the foot is distorted, and if it be pulled outward and upward the deformity which always accompanies the accident is produced; but "if the position of the limb be changed; if by laying it on its outside, with the knee moderately bent the muscles forming the calf of the leg and those which pass behind the fibula and under the os calcis are all put into a state of relaxation and non-resistance, all this difficulty and trouble do in general

vanish immediately; the foot may be easily placed right, the joint reduced and by maintaining the same disposition of the limb everything will in general succeed very happily, as I have many times experienced."



The original drawing by which Percivall Pott illustrated his description is reproduced here from the first volume of his collected works published in 1779. He says: "When by leaping or jumping the fibula breaks in the

weak part already mentioned, that is within two or three inches of its lower extremity. When this happens, the inferior fractured end of the fibula falls inward toward the tibia, that extremity of the bone which forms the outer ancle is turned somewhat outward and upward and the tibia having lost its proper support and not being of itself capable of steadily preserving its true perpendicular bearing, is forced off from the astragalus inwards by which means the weak bursal, or common ligament of the joint is violently stretched, if not torn and the strong ones which fasten the tibia to the astragalus and os calcis, are always lacerated, thus producing at the same time a perfect fracture and a partial dislocation, to which is sometimes added a wound in the integument, made by the bone at the inner ankle. When this accident is accompanied as it sometimes is by a wound of the integuments of the inner ankle and that made by the protrusion of the bone, it not infrequently ends in a fatal gangrene unless prevented by timely amputation though I have several times seen it do very well without. But in its most simple state, unaccompanied with any wound, it is extremely troublesome to put to rights, still more so to keep it in order and unless managed with address and skill, is very frequently productive both of lameness and deformity ever afterward."

Certainly the best known of Pott's writings was that which he entitled, "Remarks on that kind of Palsy of the Lower Limbs which is frequently found to accompany a Curvature of the Spine and is supposed to be caused by it." There are 83 pages for one shilling and sixpence, and it was published in 1779. In the same year it was translated into Dutch and into French at Brussels; in 1783 it was again translated into French at Paris. The influence and importance of the tract may be estimated by the fact that the particular form of disease it described was for many years known everywhere as "La Maladie du Pott", though it is now called tuberculous disease of the spine. Pott gives a masterly description of the signs and symptoms, but he did not, of course, know its cause, nor was his treatment based on any rational method. One of the specimens illustrating his paper is still preserved in the Museum of St. Bartholomew's Hospital, where it is numbered 1097.

The most interesting of Pott's tracts for the modern reader is without doubt his "Observations on the Nature and Consequences of those Injuries to which the Head is Liable from External Violence." The essay is full of well-told cases illustrating the state of London at the time it was written in 1768. Here are some examples: "A poor fellow crossing Tower Hill, got, before he was aware of it, into a mob, that was endeavouring to rescue a sailor from a press-gang. The man was knocked down. When the crowd dispersed he was found senseless and in that state was brought to St. Bartholomew's Hospital, where he was immediately let blood and put to bed. In an hour or two he was so recovered as to be able to give the preceding account.

"When Mr. Nourse [to whom Percivall Pott was assistant surgeon], whose week it was for accidents saw him the next day, the man appeared to be perfectly well, nor did any mark of violence appear on his head, except one small bruise, and that so slight, that it might with more probability be attributed to the fall than to the blow. However as he was positive that he had been knocked down by a very smart blow from a heavy weapon, and

as he had certainly been deprived of sense a considerable time thereby, Mr. Nourse bled him again and ordered him to be kept in bed and to a very low diet. At the end of three days the man found himself so well as to leave the hospital and go to work. On the twelfth day from that of the accident he came to my surgery and complained of being much out of order, said that his head was very uneasy; that he was hot, thirsty, got little or no sleep and was, at times, so faint that he could not pursue his labour. He looked ill, assured me that he had lived very soberly from the time of his leaving the hospital and that he had been in his present state for three days past. I took him into the house [i.e., the hospital] again, bled him, ordered him a glyster immediately and that he should be kept in bed.

"Next day (13th) he was in much the same state as the preceding; he had passed a restless night, had dozed now and then but awoke with much disturbance. He had a hot skin and a flushed countenance mixed with a light yellow tint. He complained of general pain and tightness all over his head, but neither to the sight nor to the touch was there any appearance or sensation whereon to build a probable supposition of particular mischief. He was again, by the physician's order, let blood and directed to take the sal absinthii mixture with a few grains of rhubarb in it every six hours. He passed the ensuing night in a disturbed manner and the next day (the 14th) was apparently worse; his skin was hotter, his pulse quicker and his pain more acute. He also now thought that one part of his head was tender to the touch and said he was sure that was the part that received the blow. This place I examined. The scalp did seem to be rather fuller than natural but by no means sufficiently so to enable me to form any judgement by. Towards the close of this day he had a slight shivering, was sick and vomited and passed the following night without any sleep at all; talking sometimes incoherently but still capable of giving a rational answer to any question which engaged his attention. On the 15th day the tumour of the scalp was more apparent, but yet seemed to contain little or no fluid and was about the breadth of a crown piece. I would have removed that portion of scalp; but while I was intending it, the poor man had a very severe rigor, which disordered him so much, that he begged to be let alone for the present. That afternoon he had two more shiverings, passed very ill the following night and next morning was delirious. The tumour now was more risen, contained palpably a fluid but was by no means tense. I took away the whole piece by a circular incision, gave discharge to a thin brown sanies and found the cranium perfectly naked, altered considerably in colour from that of a natural healthy one, but without fissure, fracture or other evil. That whole night and next day he was delirious, his skin burning hot; he had frequent spasms which shook his whole frame and the next night (the 17th) he died.

"The whole scalp, except round the edge of the incision, was in a natural state; the pericranium in every other part, except the tumid one, adhered to the bone; and neither inflammation nor tumour of any kind all over the rest of the head. Under that part of the skull from which the pericranium had been detached and from which the scalp had been removed a very considerable collection of matter was found lying between the dura mater and cranium but no appearance of disease anywhere else."

Life was leisurely in those days, for in another case "A young fellow of about twenty years was thrown from an unruly horse against one of the rails in Smithfield. The blow was great; he lay senseless for above an hour and in that state was brought into St. Bartholomew's Hospital." In like manner "A girl about fifteen years old crossing Smithfield on a market day was tossed by an ox, and fell with her head on the flat stones within the posts. As her dress was mean and nobody knew anything about her she was brought senseless into the hospital."

Domestic quarrels, then as now, caused patients to be admitted to the hospital. Thus "A woman came to my house complaining that her husband had kicked her downstairs and had broke her skull. I took her into the hospital where she was taken all possible care of, but she became first paralytic and then comatose and so died. There was a large lump of firmly coagulated blood near the origin of the medulla oblongata." "A man in the neighbourhood of St. Giles's had a quarrel with his wife in which he struck her over the head with a mop-stick. The blow was a smart one but as it fetched neither blood nor brought her to the ground it only finished the dispute and no further notice was taken of it. The woman followed her business, which was that of crying greens about the street and lived (to use her own words) sometimes drunk and sometimes sober for a week. On the eighth day from that of the blow she found herself so ill that she applied to the hospital for admission and was taken in as a physician's patient for a fever. The doctor wrote for her and the day after this (the tenth from the accident) the sister of the ward in cutting off the patient's hair which was full of vermin, discovered a swelling which she desired me to look at. It was flattish, about the breadth of a hand and lay immediately across the sagittal suture." She died on the sixteenth day from that of the accident, and upon opening the head the dura mater was found covered with matter.

Two female inhabitants of St. Giles's got drunk together and quarrelled. One of them threw a stool at the other and knocked her down. The edge of the stool cut through the scalp and broke the left parietal bone. She was trephined first on one side of her head and then on the other and died on the twenty-third day. In another case, "A watchman, whose stand was in Whitechapel, got into a scuffle with some drunken sailors and received several wounds and blows on his head from some of which he lost so much blood that he was the next day brought into St. Bartholomew's Hospital in a very weak, low state. As he had already sustained great loss of blood and was more than sixty years old I made use of no farther evacuation but dressed his head superficially and directed that he should be kept in bed. At the end of about a week when the general tumefaction was nearly gone and all the wounds in a healing state the man transgressed the rules of the hospital by staying out all night and was discharged. On the fifteenth day from that of the accident he came to me complaining of head-ache, giddiness, sickness, failure of strength, loss of appetite and want of sleep. I took him into the house again, trephined him in three places being satisfied that he had no other chance for life and was luckily disappointed in my apprehension as the bad symptoms gradually left him and the man got perfectly well."

CONGENITAL DIVERTICULA OF THE INTESTINE :

WITH THE REPORT OF A CASE EXHIBITING HETEROTOPIA.

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With a Note on its Pathology by CUTHBERT DUKES,

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The following case of congenital diverticulum of the intestine presents features so unusual that no excuse is given for recording it in detail. Except for the omission of a certain amount of irrelevant material, the case history given below is practically a verbatim report of the patient's mother, and, in view of the remarkable nature of the diverticulum revealed after removal by operation, merits the closest attention.

CASE HISTORY.

C. C., a male and only child, was born in 1909 to healthy parents. Instruments were used during delivery, and at birth the child weighed 8 lb. He was bottle-fed. From the earliest days the child was subject to frequent attacks of crying, as if in severe pain, and on this account was regarded by both parents and doctor as a 'very sensitive child'.

At 4 months, after a violent screaming attack, there was a profuse hæmorrhage from the bowel, and for some time afterwards the motions were loose, and large clots of blood were passed. From this time onwards attacks of melæna and diarrhœa were of frequent occurrence. On many occasions so much blood was lost, and the child was left so weak after the attacks, that the parents despaired of his life. At 6 years the child contracted pneumonia, and for the remainder of his childhood was subject to frequent bouts of asthma and bronchitis.

When 9 years old, and after three years of freedom, the abdominal symptoms returned, and consisted of attacks of acute pain and vomiting, occasionally accompanied by diarrhœa and melæna. At 14 years the abdominal pain was practically constant. It came on about three-quarters of an hour after food was taken, but sometimes occurred independently of food. Great care was necessary with diet, which consisted almost entirely of milk foods. These attacks of pain were of daily occurrence during the months preceding admission to hospital, and were accompanied by vomiting and the passage of foul stools. The attacks were always followed by great prostration.

The final attack which led to admission into hospital commenced on June 2, 1926, and was of greater severity than all previous ones. The pain was so severe that the patient became delirious, and frequently violent.

Morphia was given by the doctor in full doses. Nothing swallowed could be retained, and there was severe diarrhœa. This attack lasted four days, at the end of which the patient was admitted into King's College Hospital. The pain subsided on the way to hospital, so that it was difficult to give full credit to the history related by the mother.

The patient was a pale and delicate-looking boy of 16, but of average size and intelligence. On examination there was a generalized increased resistance of the abdomen, and a marked aversion to being palpated. Otherwise there were no physical signs. The patient was able to eat a reasonably full diet without much discomfort, though he occasionally had 'rumbling pains'.

In view of the history, a provisional diagnosis of polyp of the small intestine was made, and preparations for an X-ray examination of the alimentary tract were begun. The diagnosis completely failed to satisfy the parents. It had been suggested many times before, and was regarded by them as no more likely than any other of the diagnoses which had accumulated during the sixteen years of illness. It is a matter for comment that the child had so long escaped an exploratory laparotomy.

A few days after admission there was a sudden and dramatic change in the condition of the patient. The abdominal pain returned. It was first centred round the umbilicus, and later became generalized. There was frequent and violent vomiting, and the pain was so severe that the patient became delirious and difficult to keep abed. The abdomen was distended, extremely tender, and as hard as a board. After a few hours the pain appeared to reach a climax, and then suddenly ceased, leaving the patient in a state of collapse. The pulse was 120, the respirations 30, and the temperature 97·2°. The abdomen was more distended, but much less tender, and easier to examine. The liver dullness was unchanged, but there was shifting dullness in the flanks. It was evident that perforation of the gut at some level had occurred, and immediate laparotomy was performed.

OPERATION.

The operation was performed by Mr. Arthur Edmunds. A left paramedian incision was made. On opening the peritoneum a large quantity of dark fluid escaped, which was at first thought to be bile. The gall-bladder was normal. On exposing the lower abdomen the cause of the condition was soon apparent. Standing out from the small intestine was a black pear-like structure, which proved to be the blind end of a diverticulum. The black appearance was due in part to the congestion caused by a partial twist of the diverticulum as it left the mesentery. Subsequent examination showed that it was also due to the fact that the diverticulum was filled with altered blood. At a distance of three inches from the blind end there was a small perforation. The attached end of the diverticulum ran for a long distance into the mesentery, and was ultimately lost to view.

The free end of the diverticulum was dissected off from the mesentery, to which it had contracted adhesions, and followed down to the point at which it emerged from between the mesenteric leaves. It was extremely difficult

to find out where the diverticulum opened into the bowel, and a long probe inserted through the perforation failed to demonstrate this. At some distance above the point at which the diverticulum left the mesentery, the bowel was clamped and divided; but two lumina were found, of equal calibre, like a double-barrelled gun. A point still further along the bowel was taken, and the latter again clamped and divided, and this time a single lumen was found. The intestine was also clamped and divided at a point below that at which the diverticulum left the mesentery, and the diverticulum and associated portion of intestine were removed. Continuity was restored by an end-to-end anastomosis, and the abdomen closed with drainage.

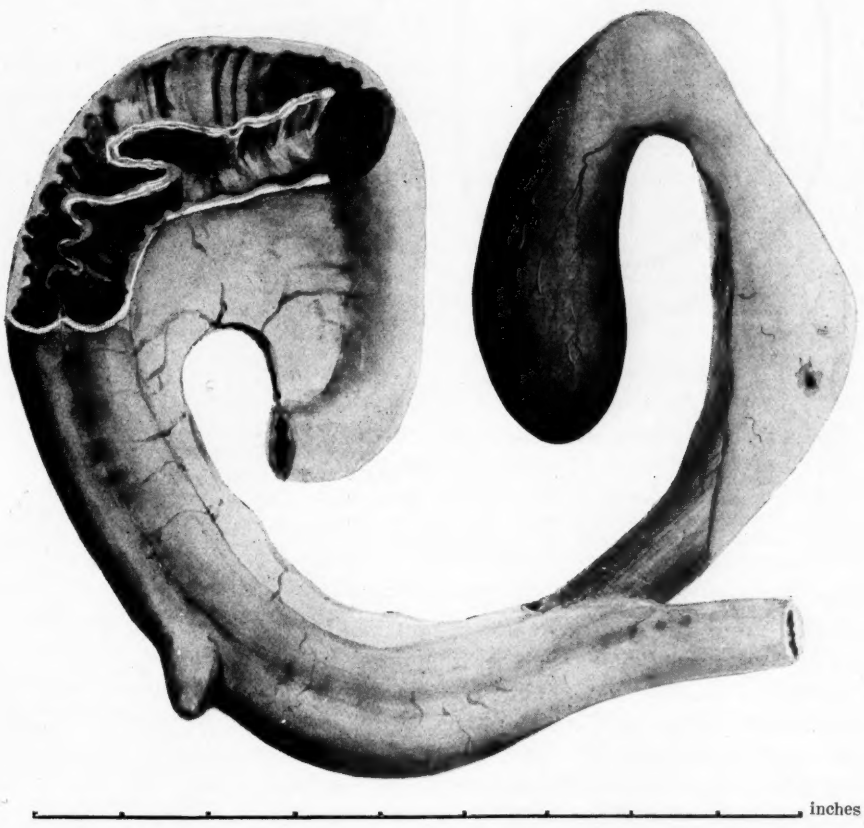

FIG. 1.—The specimen drawn to scale (2 : 5). Note the perforation, the presence of a typical Meckel's diverticulum on the segment of bowel resected, and the swollen and congested free end of the diverticulum.

During the operation the patient's condition gave considerable anxiety, and intravenous saline and injections of camphor were given. There was great improvement towards the end of the operation. The bowels were opened with an enema on the first day, and, apart from a rather alarming attack of vomiting on the third day, convalescence was rapid and uneventful.

The patient remains well, and there has been no recurrence of pain or of any other of the old symptoms.

DESCRIPTION OF THE SPECIMEN.

The diverticulum is 28½ in. long. For the first 17 in. it runs between the leaves of the mesentery along the antimesenteric border of the intestine. For the remainder of its course the diverticulum is free (*Figs.* 1, 2). The part which lies within the mesentery is of exactly the same calibre as the gut, except at its commencement, where there is a pouch-like dilatation. At the point at which the diverticulum leaves the mesentery there is a narrowing, and a little distance further a second narrowing, after which the diverticulum abruptly alters its course and terminates in a rounded bulbous extremity.

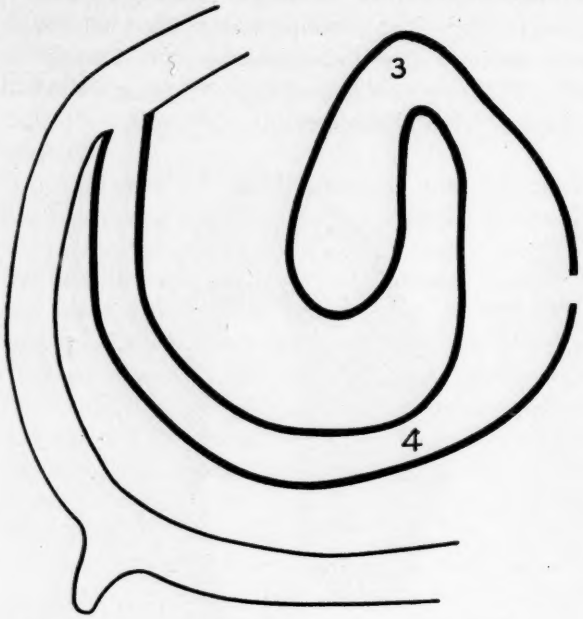

FIG. 2.—Line drawing of the specimen. The numbers 3 and 4 indicate the places from which the sections illustrated in *Figs.* 3 and 4 were taken. The gap in the diverticulum indicates the position of the perforation.

FIG. 3.—Low-power view of one of the polypoid masses within the lumen of the diverticulum. The magnification is insufficient to bring out the full contrast between superficial and deep epithelium, but shows the increased thickness of the mucous membrane. Section through 3 in *Fig.* 2. (× 8.)

The mucous membrane lining the intramesenteric part of the diverticulum looks normal to the naked eye. In the free portion the mucosa is markedly thickened, and raised to form small polypoid masses which increase in size and definition as the distal end is reached (*Fig.* 3). Three inches distal to the point at which the diverticulum leaves the mesentery there is a small perforation. This corresponds to an oval ulcer on the mucous surface, measuring three-quarters of an inch in its long axis. The ulcer has a very indurated margin, and the terraced edge is typical of chronic peptic ulceration.

The muscle and submucous coats also show considerable thickening towards the free end of the diverticulum.

The septum between the lumina of the intestine and the diverticulum commences as a thin membrane. It increases in thickness, and, at the point

where fusion ceases, consists of two complete intestinal walls except for the serous coat, the walls being separated by a thin layer of areolar tissue.

A typical Meckel's diverticulum is present on the portion of small intestine resected, and situated 7 in. from the commencement of the diverticulum (*see Figs.* 1, 2). It possesses a short mesentery, and opens into the gut midway between the mesenteric and antimesenteric borders.

There can be no doubt that the diverticulum, on account of its great size, its structure, which is identical with the intestine, and the fact that it gave rise to symptoms in infancy, is of congenital origin. Microscopic sections were prepared at various points along its wall.

NOTE ON THE PATHOLOGY.

By Cuthbert Dukes.

In structure this diverticulum exactly resembles a segment of normal small intestine. The tissues which compose its walls are arranged in their natural order, and no abnormality is to be seen, either on naked-eye or on microscopical examination, in the serous coat, in the longitudinal or circular muscle, or in the submucosa. The mucous membrane of the diverticulum, however, is appreciably thicker than that of neighbouring small intestine; its contour also is more irregular, being heaped up in some regions and thinner elsewhere.

Microscopic examination shows the mucous membrane to include two different types of epithelium. The surface layer consists of columnar mucus-secreting cells and has the appearance of healthy small-intestine epithelium. This superficial stratum provides an almost uninterrupted lining to the diverticulum, and here and there dips down into the deeper stratum, but never encroaches beyond the muscularis mucosæ. Lying beneath this single band of intestinal epithelium is a closely packed mass of glandular epithelium, the cells of which present a striking contrast to the superficial layer. These deeper wedge-shaped cells with their round nuclei and granular protoplasm do not secrete mucus, and in their shape and arrangement exactly resemble the central or peptic glands of the gastric tubules (*Fig.* 4). Arranged at the periphery of many of these glands, between the central cells and basement membrane, are large ovoid deeply-staining cells with clear or faintly granular protoplasm, which in their size, shape, and position exactly resemble oxyntic cells. In fact the histological picture presented by the deeper stratum of the mucosa is a faithful representation of human gastric mucous membrane. At one end of the diverticulum the mucous membrane is ulcerated, and here the cellular arrangement is similar to that of a gastric ulcer.

Section through the Meckel's diverticulum shows it to be lined by normal small-intestine mucous membrane.

THE MORBID ANATOMY IN RELATION TO THE CLINICAL HISTORY.

The ulcer is undoubtedly a true peptic ulcer. Its morbid anatomy, and the type of mucosa in which it has occurred, establish this. The complications of the ulcer, moreover, are typically those to which a gastric ulcer is

prone—hæmorrhage and perforation. The high percentage of oxyntic cells in the diverticulum suggests that the mucous membrane of the latter was constantly bathed in highly acid fluid, which probably predisposed the diverticulum to ulceration.

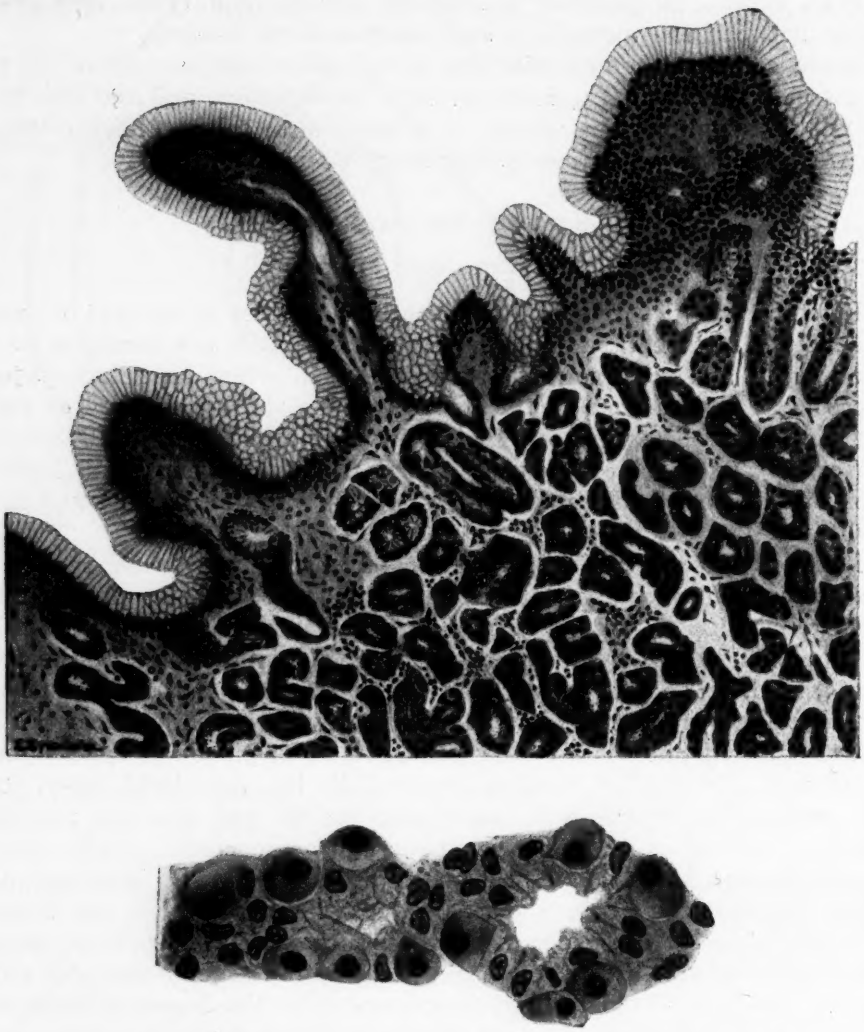

FIG. 4.—Section through the mucous membrane of the diverticulum (4 in *Fig.* 2). The superficial layer of epithelium consists of columnar mucus-secreting cells similar to the cells which line the small intestine. Beneath the superficial layer is a mass of glandular epithelium containing peptic and oxyntic cells similar to those of the gastric glands. The peripheral oxyntic cells are stained with Biebrich's scarlet. (Magnification of larger illustration = 120; of smaller = 450.)

Pain seems to have been a frequent symptom from the earliest days. The attacks may have been due in part to spasm of the wall of the diverticulum. The marked hypertrophy of the muscle coat is evidence that it was called upon to expel its contents against resistance, which was probably offered by the narrowing where the diverticulum left the mesentery. Later on, when

the child was about 14 the attacks of pain were typical of those of a gastric ulcer. They were prone to arise about three-quarters of an hour after food was taken, though occasionally they occurred apart from food. It was found necessary to keep the patient on a milk diet at this time. It seems very probable that the post-prandial pain was definitely related to the ulcer in the diverticulum. What actually produced the pain is a matter for conjecture. The ingestion of food may have caused a reflex secretion from the wall of the diverticulum, which irritated the sensitive ulcer. The fact that the diverticulum was probably always full of highly acid secretion makes this unlikely. It is more probable that the pain was muscular, and due to reflex contraction of the diverticulum following the passage of food through the pylorus. It is of interest to note that the ulcer, though some twenty feet distal to the stomach, caused pain so soon after food entered the stomach, and is striking evidence that the pain of gastric ulcer of the ordinary type is not due to the irritation of the ulcer by the food swallowed, or by increased secretion of hydrochloric acid, but is in all probability muscular.

The attacks of diarrhœa may have been due to the irritation of the lower ileum by the highly acid contents of the diverticulum. The vomiting, which in the later stages was so prominent a symptom, may have been reflex from the ulcer pain, or due to spasm of the diverticulum.

HETEROTOPIA AND ITS SIGNIFICANCE.

The mucous membrane of the diverticulum includes epithelium of both intestinal and gastric types. Such a heterotopia, or misplacement of epithelium, is not common in the small intestine, but is met with occasionally in congenital diverticula of the intestine. Taylor's[1] article on the heterotopias of the alimentary tract is a valuable survey of this interesting abnormality, and Dr. Dukes and I have nothing to add to his authoritative description from the pathological standpoint.

The great interest in the present case is that it illustrates the surgical importance of heterotopia, and brings the condition under the notice of the clinician. Taylor is inclined to belittle the clinical significance of heterotopia. In the present case it was undoubtedly responsible for a prolonged illness, and eventually originated an acute surgical condition. Judging from the vigorous appearance of the thick layer of gastric epithelium, the diverticulum must have been constantly full of gastric juice, thereby paving the way for ulceration, and thus an easily distinguishable sequence connects the three pathological conditions: (1) Congenital diverticulum; (2) Gastric heterotopia; (3) Ulceration.

Chronic ulceration in a Meckel's diverticulum is not excessively rare. Taylor[1] states that Humbert has recently collected six cases from the literature, and adds a personal one. Of these, six had repeated intestinal hæmorrhages, and no fewer than five went on to perforation. All were in boys.

Occasionally accessory pancreatic tissue, another example of heterotopia, is associated with diverticula, and may even be the cause of diverticulum formation (*see below*). Symptoms may be caused through strangulation of the intestine around bands attached to the accessory pancreatic tissue.

ETIOLOGY OF CONGENITAL DIVERTICULA OF THE INTESTINE.

The term 'congenital' is restricted to diverticula present from birth, and identical in structure with the gut from which they open—that is, they have a serous coat, a double layer of muscle, a submucous coat, and a mucous membrane.

The great majority of congenital diverticula are Meckel's diverticula. The remainder form a small group, whose etiology is little understood, and it is to this group that attention is drawn. These diverticula differ from those of the Meckelian type in that, whereas Meckel's diverticula result from an arrest of normal development, the former arise as the result of abnormal development.

Diverticula belonging to this group are most common in the ileum, but are sometimes found in the jejunum, and very occasionally in the large intestine. I can find no case of proven congenital diverticulum of the duodenum in the literature, nor in any of the medical museums visited in London. Hedinger[2] describes a case of multiple diverticula of the vermiform appendix in a new-born male child. A large umbilical hernia was present in which was found a portion of the large intestine and the appendix. The proximal two-thirds of the appendix were normal in size, and had a normal opening into the cæcum. The distal third was small in comparison, and to its apex was attached an adhesion from the hernial sac. On this portion of the appendix there were several small elevations under the serosa, which proved on microscopic examination to be a number of hernial protrusions through the muscle coat. This case is unique, as far as I have been able to determine. The diverticula, being solely hernial protrusions of the mucosa, do not come within the bounds of the definition of congenital diverticula given above, and, though present at birth, it is improbable that they are congenital in the true sense of the word. The presence of the adhesion suggests the possibility that these are traction diverticula, produced at a comparatively late period of intra-uterine life.

The diverticula of this group vary in size and shape. Some are cystic in form, and communicate with the bowel through a narrow aperture. Others are short and tubular, and associated with the presence of accessory pancreatic tissue. Others, again, are of great length, as in the case described above. In *Keen's Surgery*[3] these diverticula are discussed under two heads, ancestral and inclusion diverticula. The former are described as conical, arising from the ileum, and are regarded as of an ancestral nature, analogous to the appendages found in rabbits and cats: this type probably belongs to those arising in connection with accessory pancreatic tissue. The latter (inclusion) diverticula are described as almond-sized, sometimes pedunculated and occurring on the free border of the gut, and are regarded as probably related to the vitelline duct. This group, presumably, corresponds with the cyst-like diverticula mentioned above. No reference to the giant type is made.

The following classification will therefore be adopted for description. It is based partly on cases examined personally, and partly on references in the literature: (1) *Cyst-like diverticula;* (2) *Diverticula associated with the presence of accessory pancreatic tissue;* (3) *Giant diverticula.*

1. CYST-LIKE DIVERTICULA.

In the Museum of St. Bartholomew's Hospital is a specimen (No. 1925 a 1) described as a congenital diverticulum of the jejunum. It was removed post mortem from an infant who died with signs of intestinal obstruction. The specimen consists of the stomach and a portion of the small intestine. Eleven inches from the pylorus is a large cyst-like structure situated between the leaves of the mesentery. It communicates with the lumen of the jejunum by two orifices of unequal size. The smaller orifice is about 2 mm. in diameter, and has a regular margin. The larger orifice has an irregular margin, which suggests the possibility of its being an artefact. At the level of the diverticulum the gut is narrowed, but is dilated above. Microscopically the wall of the diverticulum is indistinguishable from that of the bowel.

Considerable doubt exists as to the mode of origin of a diverticulum of this nature. Its shape suggests very clearly that it bears a relation to cysts of the intestinal wall. Tiedman[3] records a case of intestinal diverticulum in which the communication with the bowel would only admit a fine probe. Numerous cases of complete cyst are to be found in the literature. Hunter[4] describes a bilocular cyst related to the jejunal wall, identical in structure with the gut, but completely shut off. I have recently described a case of cyst of the cæcal wall,[5] and MacAuley[6] has collected nine cases from the literature, and added one occurring in his own practice, of cysts in the ileocæcal region.

These being the facts, it is probable that cyst-like diverticula and true cysts of the intestinal wall share a common etiology. It is difficult, however, to determine their exact relation. A diverticulum may result from a cyst by acquiring a secondary communication with the bowel. Conversely, a cyst may be formed from a diverticulum by the sealing off of the latter's communication with the bowel.

The work of Lewis and Thyng[7] is invariably mentioned in connection with the etiology of cysts and diverticula. These observers found pouch-like processes arising from the gut, and epithelial nodules occurring in the wall of the gut, in the majority of the early embryos of the rabbit, the pig, and man, which they examined. They conclude that diverticula may result from the persistence of such pouches, and that cysts may arise from degeneration of the epithelial nodules. These findings were confined to the small intestine, with the exception of one case in which a collection of pouches was found opening from the cæcum.

As far as I know, these striking observations have not been confirmed. Moreover, these pouches and nodules were found in the majority of specimens, and were usually multiple, whereas both congenital cysts and diverticula are, in practice, very rare and always single. Gfeller[8] regards the cysts as arising in connection with an unobliterated omphalo-meseraic duct, either by separation of a part of the intestinal *Anlage* or by germinal displacement. This is unquestionably the most likely hypothesis, and it would appear that the cyst-like diverticula referred to are formed from intestinal cysts by the acquisition of a secondary communication with the lumen of the bowel.

2. DIVERTICULA ASSOCIATED WITH THE PRESENCE OF ACCESSORY PANCREATIC TISSUE.

These diverticula do not form so well defined a group as the above, and there is little doubt that the majority of specimens described as such are examples of Meckel's diverticula containing pancreatic tissue, an occurrence which, as before mentioned, is not infrequent. Clogg[9] was the first to draw attention to the subject in this country, in recording the case described below.

The diverticula are similar to Meckel's in size, shape, and situation, and I should be content to consider them all as of Meckelian origin were it not for the case quoted by Nauwerck.[10] In this case two were present. One was situated 80 cm. above the ileocæcal valve, and in all respects resembled a Meckel's diverticulum. The second was situated 2 cm. above the valve, and at its apex was attached an accessory pancreas possessing a duct. It is a well-established truth, as we shall have occasion to state further on, that two diverticula of Meckel cannot be present in one intestine. It follows that the second diverticulum could not have been of Meckelian origin, and the case furnishes proof that diverticula of this group can and do occur independently of Meckel's diverticula. It is probable that these diverticula owe their presence to the accessory pancreas, possibly because of traction exerted by the latter upon the wall of the fœtal intestine.

Clogg shares the view that the majority of recorded cases are Meckel's diverticula. His case may have been either. It occurred in a boy of 12. Laparotomy was performed for acute intestinal obstruction, and a loop of ileum was found strangulated below a band of fibro-fatty material which ran between the right iliac fossa and the apex of a diverticulum. The latter and a portion of the band were removed: it measured $\frac{3}{4}$ in. in length, and its structure was identical with that of normal small intestine. To its apex was attached a nodule of pancreatic tissue, also measuring $\frac{3}{4}$ in. (in diameter). It had developed within the wall of the diverticulum, and possessed no duct. Clogg quoted seven other cases from the literature, including the case of Nauwerck.

3. GIANT DIVERTICULA.

In view of the case described, chief interest centres around diverticula of this type. Though the condition is of considerable rarity, two cases have been published of recent years which afford striking parallels with my case—one of the small intestine recorded by Moll,[11] and the other of the large intestine by Garnett Wright.[12]

Moll's example is of exceptional interest, for not only were the anatomical findings similar to the present case, but the condition gave rise to a clinical picture which is almost identical. The likeness was carried to completion in that the pre-operative diagnosis in both instances was the same—intestinal polyp. Moll's specimen was in a child 5 months old. Melæna had occurred two days after birth, and before the child was $2\frac{1}{2}$ months old there had been two further severe attacks. At 5 months the infant was admitted into hospital for another severe attack of bleeding, and a diagnosis of intestinal polyp was then made, and laparotomy performed. At operation free fluid

was found in the peritoneal cavity, the mesenteric glands were enlarged, and the condition was regarded as probably tuberculous. Death occurred a few days later. At autopsy a diverticulum 33½ in. long was found, opening from the small intestine two feet above the ileocæcal valve. It appeared to be identical in structure with the small gut. At its origin from the ileum there were two chronic ulcers, which Moll regards as the source of the hæmorrhage during life.*

In Wright's case the diverticulum was found in a woman of 27, who had given a history of constipation for many years. The diverticulum arose from the sigmoid colon, and was 37 in. long. At the commencement the adjacent walls of the bowel and diverticulum were indistinguishable. Fusion ceased 3 in. from the distal end, which occupied a position behind the peritoneum. The diverticulum resembled the gut in structure. The longitudinal fibres were evenly divided between the bowel and the diverticulum in the following way. The tænia libera was present on the true bowel but not on the diverticulum; the tænia mesenterica was present on the diverticulum but not on the bowel; the tænia omentalis bifurcated, half remaining on the bowel wall, and half passing on to the diverticulum.

ORIGIN.

All three cases resemble a reduplication of the gut, and it seems probable that they share a common etiology. It is unlikely that any theory of origin that will not satisfy all three is correct.

Moll regarded his case as a giant Meckel's diverticulum. This view cannot gain acceptance on the analogy of the case I have described, for in the latter a typical Meckel was actually present on the segment of bowel resected with the diverticulum (*see Fig.* 1). Two diverticula of Meckel never occur in the same bowel. To quote Howell Evans,[13] ". . . there is only one possibility of origin for two diverticula of Meckel, and that is when the omphalo-meseraic duct has longitudinally bifurcated in association with a double small intestine."

In discussing the origin of Garnett Wright's case, Sir Arthur Keith[14] suggested that the diverticulum might have arisen by the development of a median septum within the lumen of the bowel at an early stage of embryonic life, and pointed out that the exact division of the longitudinal muscle fibres between the diverticulum and the true bowel supports this view. Sir Arthur Keith, who has very kindly discussed my own case with me, is not, however, convinced that this view of the origin of giant diverticula is correct. The theory is certainly open to criticism. There is no case on record of a median septum occurring in the bowel. The nearest approach to this that I have seen is Specimen 1222–1 General Pathology Section, R.C.S. Museum. This shows a portion of the small intestine of an ox, to one side of which is a long

* Since this article was sent to press, Professor Stuart and Dr. Moll have prepared microscopic sections from the wall of the latter's case. It is of great interest that the appearance of the mucous membrane in this case is identical with that of the case I have described, i.e., gastric heterotopia is present. Thus the identity of these two cases is established from both the clinical and the pathological standpoints.

tubular cyst of the same calibre as the intestine itself. At either end the cyst terminates blindly, and does not communicate with the intestine. The cyst mucous membrane does not, however, resemble that of the gut, and this makes it improbable that the wall common to the cyst and the intestine arose as a median septum within the lumen of the embryonic bowel. The cyst in all probability resulted from relics of the omphalo-meseraic duct.

Even supposing the formation of a median septum be accepted, in order that a diverticulum should form, the septum would need to gain attachment to the side wall of the bowel in order to form the blind end of the future diverticulum. No provision in the theory is made for this.

All three cases undoubtedly represent a true reduplication of the bowel, of which many other examples, of both small and large intestine, are on record. The best example of reduplication of the small intestine is Pollard's famous case, now in the R.C.S. Museum (Specimen 548 B—Teratological Series). Pollard's description of the case is as follows: "At a distance of 24 in. from the pylorus the intestine bifurcates. The two segments are similarly supplied with mesentery, so that it is only by tracing them that the diverticulum and intestine can be distinguished. The diverticulum after a course of 36 in. reaches the umbilicus, beyond which it originally terminated as a large cul-de-sac in the umbilical cord." The other segment ended at the ileocæcal valve after a course of 63 in.

Blair Aitken[16] describes a case of reduplication of the large bowel in a two-day-old child with a large umbilical hernia. Bifurcation was present from the lower end of the ileum to the perineum. One of the segments ended normally, and the other within the valvular cleft just within the posterior commissure. Bland-Sutton mentions that a French surgeon, Brignolles, discovered a double pelvic colon when operating for appendicitis. Schwalbe, quoted by Aitken,[16] records a case of double appendix; Meckel[17] a fœtus with two cæca (originally described by Boerhaave in 1757); Grawitz[18] found in a man of 55 an accessory portion of bowel in a hernial sac, and arising from the ascending colon, in the form of a U-shaped segment. The limbs of the U united to form a common opening into the bowel. At the summit of the U there was a transverse occlusion.

Extreme degrees of reduplication and malformation are sometimes found. There is a specimen (No. 3631) in the Museum of St. Bartholomew's Hospital removed from a negro, in which the intestines are enclosed in a kind of sac. Three separate ilea open into the cæcum. One is small, and begins and ends in the cæcum by two orifices set close together, but the other two are of considerable length.

Reduplication is far more common in the lower animals than in man. Even triplication is sometimes found. Such deformities are most common in birds. There is a specimen in the R.C.S. Museum (D 547—Teratological Series) of the intestines of a duck with three fully-formed cæca. All are of the same length, and open into the bowel at the same level. According to Mitchell,[19] paired cæca occur normally in the hyrax and certain of the Sirenia.

It is manifestly impossible to draw a distinction between giant diverticula and the more obvious reduplications of the intestine, except in the matter of degree. Of the same order is the example of gross deformity in

St. Bartholomew's Hospital Museum, and we must seek an origin applicable to the group as a whole. It is at once apparent that septal theories of origin are inadequate.

Can the conditions be examples of reversions to type? This hypothesis is at once put out of court for small-intestine cases by the fact that there is no animal in which reduplication of the small intestine normally occurs. The rare cases of reduplication of the cæcum may find an explanation here, however. Mitchell[19] holds, and brings forward strong evidence in substantiation, that the cæcum of primates is a rudimentary survival of an originally paired cæcum.

In the search for an origin we must study reduplication of growth as a whole. The most complete example of reduplication is that of twin organisms capable of independent existence. That twins may develop from a single ovum is an established fact. Under certain conditions, of which we know nothing, the reduplication is not perfected, and conjoined monsters may result. Many examples are to be found in the literature. Patrick[20] has recently described a thoracopagus, Cameron[21] a craniopagus, and Oag and Drinkwater[22] an ischiopagus. In the first of these cases the only unpaired structure is the small intestine above Meckel's diverticulum; in the last the only unpaired structure is the ascending colon. It is not an impossible stride for the imagination to picture a reversal of this—pairing of a segment of the intestine in an otherwise normal individual.

Equal growth may not occur in the twins. One may reach full maturity, though not losing its connection with a fellow which has but imperfectly developed, and which constitutes a parasitic fœtus. Bland-Sutton[23, 24] has given examples of this phenomenon both in man and in animals. In these cases the stimulus to reduplication, although acting at an early stage of cell division, has affected a certain section only of the embryo, e.g., the caudal end in the parasitic calf described by Bland-Sutton,[23] or the cephalic end in the example of bicephaly of the same author.[24] The stimulus may be limited even to the cells differentiating to form a single limb, as in another case furnished by Bland-Sutton.[25] In this case an arm projects from the sacral region. Teratomata are of similar origin, but differ in that the property of proportionate growth is lacking.

Another and still less pronounced example of reduplication is the occurrence of double external genitalia. On the same analogy this may be regarded as a minor twin, the stimulus to reduplication affecting only those cells from which the genitalia are developed. Volpé's[26] case is of exceptional interest, for in this reduplication of both lower urinary apparatus and the intestine was present.

Experimentally it has been found possible to divide the fertilized amphibian ovum and produce twin embryos to the stage of completion of the gastrula.[27, 28] Attempts to produce twin embryos at a later stage have resulted in the production of *duplication of some part or parts of the body.* This fact is of extreme significance. It clearly shows not only that duplication of growth depends on forces acting upon the developing ovum, but that the extent of the duplication depends upon the stage of development the ovum has reached when the stimulus falls—thus a perfect twin in the earliest phase

of development, and a limb or a segment of bowel in a later phase, the particular part of the body affected depending upon which cells received, and reacted to, the stimulus.

The examples of giant diverticula quoted and described above are undeniably examples of reduplication of the intestine. In my opinion they owe their origin to forces acting upon the embryo during the differentiation of cells to form the primitive gut, with resulting duplication of a segment of the bowel, the forces being identical with those which determine twin growth.

HETEROTOPIA AND REDUPLICATION.

Can the occurrence of heterotopia be reconciled with the theory of origin formulated for the diverticulum ?

The primitive layer of gut is lined with a layer of entodermal cells capable of developing into any of the types of epithelium found in the course of the adult alimentary canal. What determines their development into the specialized epithelium desired of them is not known. But if the part is a malformation possessing no useful function—e.g., a Meckel's diverticulum—the primitive entoderm appears to lack control, and may exercise any of its potentialities, and develop into a type of epithelium foreign to the region of gut in which it occurs (heterotopia). This is what has happened in the diverticulum described. Present at an early stage in the development of the alimentary canal, it is lined with a single layer of entodermal cells capable of developing into any type of alimentary epithelium. They have chosen to form a double layer, intestinal and gastric. This phenomenon in no way interferes with the theory formulated for the diverticulum. It goes to show, in fact, that the diverticulum was present at a very early stage of development, before differentiation of the entoderm had commenced.

SUMMARY.

1. A case of congenital diverticulum is described which caused symptoms from infancy and eventually perforated through a chronic ulcer. The diverticulum was removed at operation, with recovery.

2. The mucous membrane of the diverticulum contains a layer of gastric mucosa, thus exhibiting the phenomenon of heterotopia.

3. Cyst-like diverticula form a distinct group of congenital diverticula of the intestine. It is thought that they develop from cysts of the intestinal wall.

4. Diverticula associated with the presence of accessory pancreatic tissue, and due, possibly, to traction by the latter, do occur, but are often difficult to distinguish from diverticula of the Meckelian type, in which pancreatic heterotopia is not uncommon.

5. Giant diverticula may occur in both the small and large intestine. They are not allied in any way to Meckel's diverticula, nor can their origin be due to growth of a median or transverse septum within the fœtal intestine. Those of the small intestine cannot be regarded as atavistic. They are in all probability true reduplications of the bowel, similar to the more extreme examples of reduplication and malformations of the bowel. In the writer's

view they represent an attempt at the formation of a twin, which has come at a comparatively late stage of development of the ovum, so that the extent of reduplication is limited to a segment of the bowel.

My thanks are due to Mr. Arthur Edmunds for allowing me to investigate the case upon which this article is based, and for *Figs.* 1 and 2. To Dr. Cuthbert Dukes I am specially indebted, for without his help I should not have recognized the condition of heterotopia. My thanks are also due to Mr. S. Steward, of the Royal College of Surgeons staff, for the very beautiful coloured drawings he has prepared from microscopic sections, and to Sir Arthur Keith and Dr. Shore for permission to refer to specimens in the Royal College of Surgeons Museum and St. Bartholomew's Hospital Museum respectively.

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FRACTURES OF THE PELVIS: AN ANALYSIS OF 100 CASES.

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Fractures of the pelvis, whether of the individual bones constituting the pelvic girdle or of the whole pelvic girdle, are becoming progressively more frequent every year. This is in great part due to the ever-increasing number of motor vehicles which are to be seen on the roads. Deaths from motor accidents in England and Wales were: 3412 in 1925, 4075 in 1926, and 4495 in 1927. This gives an average of more than twelve deaths per diem, and it should be remembered that these figures take no account of the number of persons seriously injured or of those suffering from minor injuries.

The majority of fractures of the pelvis are caused by street accidents; other causes being severe crushes and falls from considerable heights.

Fractures involving the whole pelvic girdle are the most important owing to the consequent liability of visceral complications, such as rupture of the urethra, bladder, or intestines. These complications are emphasized in every text-book on surgery, but it is a curious fact that they very seldom result from such fractures.

The following 100 cases have come under my supervision during the years 1915–28, and occurred as follows:—

Fractures of the whole pelvic girdle ..	44
Fractures of the ilium	18
Fractures of the os pubis	24
Fractures of the ischium	5
Fractures of the acetabulum	2
Fractures of the sacrum	4
Fractures of the coccyx	3
Total	100

Anatomical Considerations.—Before considering these fractures it will not be out of place to make a few remarks on the bony pelvis, since it is obvious that when direct trauma is applied to the pelvis the weakest parts are mainly affected.

The posterior half of the bony framework of the pelvis is subject to greater stresses and strains imposed upon it by the body weight and muscle traction and is consequently much stronger than the anterior half, which is comparatively weak. The symphysis pubis—the integrity of which depends mainly upon the subpubic and suprapubic ligaments—cannot be regarded as a strong joint, and trauma may cause dislocation of the symphysis instead of a fracture of the pubic rami. Traumatic dislocation of the sacro-iliac joint,

on the other hand, in the absence of disease of the joint, is almost unknown. The posterior sacro-iliac ligaments are some of the strongest, if not the strongest, ligaments found in the human body. The acetabulum might be regarded as one of the weak spots in the pelvic girdle, but this is far from being the case.

If the hip bone is manipulated, it can be easily recognized that by far the thickest and strongest part of the bone is a bar which extends from the auricular surface to the acetabulum. This bar may be compared to a three-sided pyramid the apex of which is situated at the upper part of the auricular surface, while its enormously thick base supports the upper part of the acetabulum. This thickened bar of bone obviously enables the hip bone to withstand the great stress of the body weight transmitted thereby from the sacrum to the head of the femur in the erect posture. There is further a second but much less well marked thickening of the hip bone extending from the tuberosity of the iliac crest (the prominent boss on the forepart of the iliac crest to which the ilio-tibial band is attached) to the upper part of the acetabulum. This thickening is again more or less pyramidal, and its base merges with that of the weight-resisting bar at the upper part of the acetabulum. *Fig.* 5 represents the medial aspect of the right hip bone. The bone is supposed to be translucent in order to appreciate the relative positions of the auricular surface and the acetabulum. In order to appreciate the positions and form of the two strengthening bars the actual thickness of the bone in its various parts is indicated by stippling.

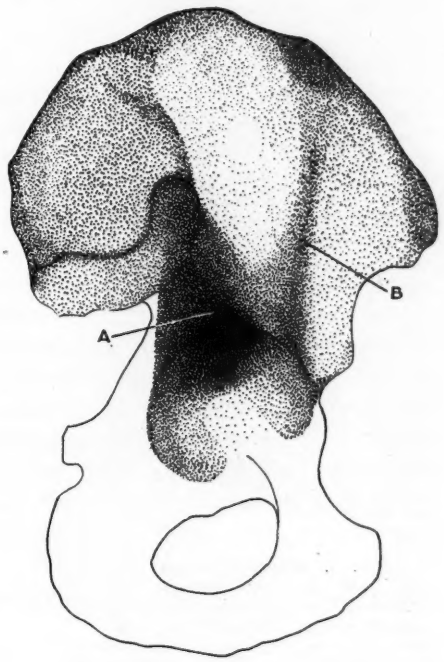

FIG. 5.—Diagrammatic representation of the medial aspect of the right hip bone. The thickness of the bone is indicated by stippling; the denser the stippling the thicker the bone. A, The thickened bar stretching from the upper part of the auricular surface to the upper part of the acetabulum, the latter being by far the thickest part of the bone; B, The less well-marked bar stretching from the tuberosity of the iliac crest and merging with A at the upper part of the acetabulum.

If a section is made through the hip bone in a plane corresponding to a line drawn from the upper part of the auricular surface to the acetabulum, it will be seen (*Fig.* 6) that the strength of the weight-resisting bar of the bone does not depend alone on the actual thickness of the bone, but also upon a peculiar and remarkable arrangement of the bony material. In the cancellous tissue two sets of pressure lamellæ may be seen diverging from the auricular surface and impingeing upon two relatively very thick interjections of the surface compact bone on either side. These interjections are comparable with the calcar femorale upon which the resistance of the inner

side of the neck of the femur is so largely dependent; from them spring two sets of lamellæ which converge on to the upper part of the acetabulum, where again the compact bone is remarkably thick. There are thus two sets of lamellar arches in the cancellous bone interposed between the auricular surface and the acetabulum, inverted as regards one another and supported by buttresses of compact tissue. A more adequate arrangement for resisting stress cannot well be imagined. This peculiar cancellous tissue occupying the interval between the auricular surface and the acetabulum is sharply demarcated from the more or less round-meshed cancellous tissue occupying the upper and hinder part of the bone which is subject to the pull of muscles and ligaments and does not directly resist the body weight.

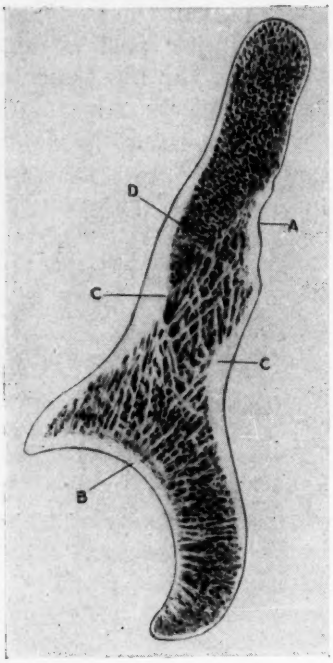

FIG. 6.—Section through the hip bone passing through the thickened bar stretching from the upper part of the auricular surface, seen in profile (A), to the acetabulum (B). The peculiar arrangement of the cancellous tissue in this bar, the two interjections of compact bone (C), and the sharp line (D) demarcating the cancellous tissue occupying the upper and lower parts of the ilium, may be noted.

An interesting fact which may be gathered from examining sectionized bones of young subjects is that the two supporting bars of the hip bone are not noticeable at birth, are obvious at the end of the first year, and become very distinct by the third year.

Certain well-known features of pelvic fractures now become intelligible. Owing to the resistance which the bases of the two thickened bars of the hip bone confer upon the upper part of the acetabulum, fractures of the acetabulum, and especially of the upper part of the acetabular lip, are of relatively infrequent occurrence. In most cases of fracture of the ilium the lines of fracture do not pass downwards and forwards from the point of application of the trauma, but invariably stop short in the region of the main bony bar.

Fracture of the Whole Pelvic Girdle.—An examination of 44 cases of fracture of the whole pelvic girdle and a comparison of their skiagrams make it clear that there are two common types :—

1. The first type is one in which the fracture is oblique in nature, causing a solution in continuity of the pubic rami on one side and an irregular fracture of the sacrum and posterior part of the iliac crest on the other. Most of these cases were the result of the patient having been run over either by the wheel of a cart or by a motor-car. The initial force is borne by the pubic rami, and as the vehicle passes over the pelvis the body rolls over with the wheel and the final force is directed to the opposite side. Sometimes the fracture runs through the horizontal ramus of the pubis and the ascending ramus of the ischium, while in other cases the body of the pubis is fractured (*Fig.* 7).

The pelvis as a whole is a compressible girdle, more particularly in children, many of whom have been run over by light cars where the wheels have passed over the pelvis and no fracture has resulted. This is no doubt due to the elasticity of the pelvis as a whole—a characteristic which is notable in young subjects but diminishes as age advances. The lateral masses of the sacrum are stronger behind than in front, a fact associated with the very strong posterior sacro-iliac ligaments which are there attached, and with the anatomical fact that the sacro-iliac joint is supported posteriorly by the posterior part of the iliac crest.

In some cases the fracture through the posterior part of the pelvic girdle involves the lateral mass of the sacrum only, and the posterior part of the iliac crest is uninjured.

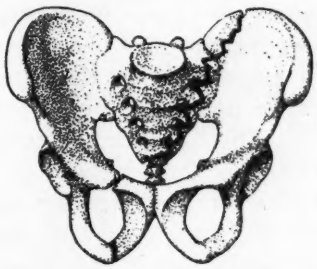

FIG. 7. — Oblique fracture of the pelvic girdle. The lateral part of the sacrum and the upper and hinder part of the ilium are fractured on the left side; the bones bounding the right obturator foramen above and to the medial side are fractured on the right side.

2. The second type of fracture of the whole pelvic girdle is one in which the fracture is limited to one side only. The common cause of this lesion is an antero-posterior compressing force such as a severe crush. This type is not so common as the former, although it is fairly frequent in 'shunters', who are liable to accidents from the compressing force of the buffers of railway trucks. Complications are more likely in this second type, owing, no doubt, to the fact that the initial force is greater and more sustained. As a rule the fracture traverses the rami of the os pubis and ischium and the anterior sacral foramina on the same side (*Fig.* 8).

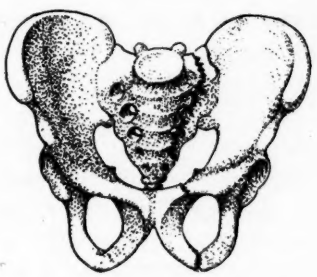

FIG. 8. — Fracture confined to one side of the pelvic girdle. The lateral part of the sacrum, the bones bounding the obturator foramen above and below, are all fractured on the left side.

In some cases where the trauma is very great the sacrum may be fractured on both sides and driven into the pelvic cavity; these are usually fatal, and no such example is recorded in my series. Vergorz[1] reported a few cases in which a double fracture occurred and a fatal result did not ensue.

The diagnosis of a case with a fracture of the whole pelvic girdle usually presents little difficulty. Many cases come under observation in a state of shock, and it is noticed that the pelvic girdle appears to be 'splayed'; the abdomen seems to be continuous with the thighs, and there is no indication of the fold due to Poupart's ligament. The patient complains of pain in and about the os pubis and will often remark that he feels as if he were 'falling to pieces'. Usually there is considerable pain on coughing. Careful palpation will in many cases demonstrate a fracture in the pubic bone. On no account should an attempt be made to elicit crepitus, as by so doing damage to the membranous urethra may result, or if this structure is already torn, the rent may be made worse. Examination of the rectum may reveal a fracture of the sacrum.

The chief dangers which may co-exist with a fractured pelvis are certain visceral lesions, such as damage to the urethra, bladder, or rectum. It is most important to exclude any of these complications when the case first comes under observation. The membranous portion of the urethra which occupies the interval between the two layers of the triangular ligament is the part of the urethra most likely to be torn, especially if there is any displacement of the pubic rami or of the symphysis. The injury to the bladder may cause an extra- or intraperitoneal rupture depending mainly on the force of the trauma and the degree of the distension of the organ. The rectum may be punctured by displaced fragments of bone, but this complication did not occur in any one of my series, and must be a very rare one.

The treatment should be prompt. Every care should be taken when the patient is moved, as if any visceral complications are present, they may be easily increased by movement. The patient should be put to bed on a divided mattress with fracture boards beneath it, and kept warm and quiet until the shock has passed off. A rubber catheter should be passed and the urine drawn off and examined; if it is blood-stained, the catheter should be tied in. If it is impossible to pass a catheter owing to laceration of the urethra, a perineal incision must be made to prevent urinary infiltration, and the rent in the urethra sutured over a rubber catheter. A broad binder should be firmly applied to the pelvis and kept in position for ten days, when plaster-of-Paris breeches should be applied. The fixation in plaster ought to be maintained for fully six weeks, after which it can be removed and the patient allowed to move about in bed. A skiagram should be taken to ascertain the amount of union and callus formation: active and passive movement may then be commenced. The patient should be allowed up on crutches after nine weeks, and will usually be able to discard these after three weeks—that is, three months from the time of the accident. In cases where there is a difficulty in determining whether a rupture of the bladder is intra- or extraperitoneal it is better to open the peritoneal cavity first, as suggested by Sir William Wheeler.[2] Any urine or blood in the peritoneal cavity should be removed by means of a siphon, the rent in the bladder repaired, and a catheter tied in. If the rupture is extraperitoneal, the site of the rent is usually on the anterior surface; the opening can easily be closed, a drainage tube should be passed into the cave of Retzius, and a catheter tied into the bladder. Very rarely the rent in the bladder is near the base. In these cases it may be impossible to insert any stitches, and the surgeon will have to resort to suprapubic cystotomy.

In cases where the wall of the rectum is definitely lacerated owing to the penetration of a fractured portion of the sacrum, the best method is to perform a colostomy at once in order to prevent any pelvirectal suppuration.

In 1926 Gardner[3] reported a case of fractured pelvis with insignificant skin abrasions and no crushed or extensively devitalized part. This patient died from a fatal infection caused by the *Bacillus welchii*. Such a complication must be very rare.

An analysis of 44 cases of fracture of the pelvic girdle shows that there were 32 males and 12 females. The causes in this type of fracture were: Accidents caused by vehicles 30; crushes 8; falls from windows, etc. 6.

In 28 out of the 44 cases the type of fracture was oblique (*see Fig.* 7); in the remaining 16 cases the fracture was limited to one side or other of the pelvic girdle (*see Fig.* 8).

Visceral complications occurred in 6 cases only; 5 of these were in men and the other case was that of a girl, age 8. All these were run-over cases, and in every instance the fracture of the pelvic girdle was oblique. The visceral complications were as follows: 3 cases of rupture of the urethra; 3 of rupture of the bladder (2 extraperitoneal, 1 intraperitoneal). In this series of 44 cases there was not one in which the rectum was injured.

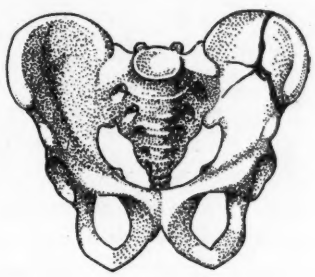

FIG. 9.—A stellate fracture of the left ilium caused by direct traumatism.

Fracture of the Ilium.—The 18 cases of fracture of the ilium were all caused by direct traumatism (*Fig.* 9): 12 cases occurred in males and 6 in females. Street accidents accounted for 11 cases; 2 were caused by a kick from a horse, and 5 were due to falls, generally from a height varying from three to ten feet.

There were no visceral complications: the one and only trouble in the 18 cases was a large hæmatoma in the iliac fossa; but this gradually diminished in size and eventually disappeared. They all showed varying degrees of comminution, but in every case sound union was obtained. Such a result would be expected in these fractures, although in some the degree of comminution was very great, because the ilium is closely invested with muscles on either side, and these muscles in themselves provide excellent splints.

The treatment in this type of fracture is similar in every way to that advised in cases where the whole pelvic girdle is involved. Although avulsion of the anterior, superior, or inferior iliac spines does occur, I have never come across a case.

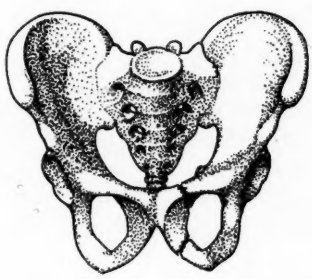

FIG. 10.—Fracture confined to the os pubis. The two rami of the os pubis are fractured on the left side.

Fracture of the Os Pubis by Itself or of its Rami.—This seems to be the second commonest type of fracture of the pelvis, and occurred in 24 cases in my series (*Fig.* 10): 14 patients were males and 10 females. The causes of the fractures were: Accidents caused by vehicles 16; crushes 4; falls 4.

Visceral complications occurred in 5 cases, and these all resulted from being run over by vehicles. In 3 male cases the urethra was ruptured; in 2 extraperitoneal rupture of the bladder occurred—one in a male and the other in a female.

The treatment in this type of fracture is similar to that in which the whole pelvic girdle is injured.

Fracture of the Ischium.—This is an uncommon form and was met with in 5 cases only. All the cases occurred in men, and were the result of a heavy fall on the buttocks; in 4 the tuber ischii alone was fractured and

there was practically no displacement. In one case the whole ischium was fractured with slight displacement of the fragments.

These patients were treated by rest in bed for a period of six weeks, then massage was given for two weeks and the patients were allowed up for a short period, after which they were discharged. Union was good in every instance and there was no disability whatever.

Fracture of the Acetabulum.—Only two cases of this condition occurred in my series :—

The first case was a fracture of the posterior lip in a man, age 38, who was thrown from his horse, his left leg becoming entangled in the stirrup. He was dragged along the ground for ten yards or so, when his horse attempted to jump a hedge and his foot slipped out of the stirrup. On examination he was found to have a posterior dislocation of his left hip-joint, and X rays showed that the posterior lip of the acetabulum was fractured. The dislocation was reduced under anæsthesia, and the leg put up on extension with external rotation and abduction for two weeks. After this the pelvis and thighs were immobilized in plaster-of-Paris breeches for six weeks. Owing to the extensive bruising of the soft parts it was considered unwise to immobilize the pelvis in plaster immediately after the accident. When the plaster was removed it was found that firm union of the fracture had taken place. The patient was not allowed to put any weight on his left leg for another three weeks, but was permitted to walk about with the use of crutches. No disability whatever resulted.

The second case occurred in a girl, age 12, who was knocked off her bicycle by a motor-cyclist. She was thrown on to the edge of the pavement, and sustained a stellate fracture of the acetabulum. The force in this case was transmitted through the neck and head of the femur as the point struck was the great trochanter of the femur. The patient was treated with weight extension for two weeks and then immobilized in plaster for six weeks. Walking was permitted after three months. It might be thought that walking would have been allowed after two months, but as in this case the Y-shaped acetabular cartilage must have been severely traumatized, it was thought advisable to keep the girl off her feet, otherwise there was a definite risk of imperfect growth of the ossific centre of the acetabulum. A good anatomical and functional result was obtained.

Although fractures of the anterior lip and fractures through the centre of the acetabulum (central dislocation of the hip) have been described, no such examples occurred in my series of cases.

Fracture of the Sacrum.—This is always due to severe local direct violence. Four cases occurred in the present series, the two sexes being equally affected. The cause of the fracture was a kick from a horse in two cases, and a fall on to the edge of the pavement in another, while the remaining case was due to a kick during a game of football.

In none of these cases was there much displacement, although in two, where the fracture traversed the 4th sacral segment, the lower end of the sacrum and the coccyx projected forwards and could be easily felt on rectal examination. The rectum was not injured in any of the four cases. One of the female patients developed some neuralgia of the 4th sacral nerve,

probably owing to callus formation. The treatment adopted was similar to that of fracture of the whole pelvic girdle.

Fracture of the Coccyx.—This condition is not so uncommon as might be imagined, three cases being noted in the hundred under review. One occurred in a man who slipped off a window-sill while cleaning an outside window; he fell about four feet and landed astride a water bucket. The other two cases occurred in women and were due to falls on the buttocks.

In all these cases the coccyx was displaced forwards, but was easily replaced into its normal position by manipulation with a finger in the rectum. The patients were treated simply by rest in bed. The man did very well; the union was sound, and when seen a year after the accident he reported that he had no pain or discomfort. The other two cases did well for a time; in one case the coccyx united in a bad position and was excised; in the other the patient remained well for eighteen months, when coccydynia developed, and, palliative means proving useless, excision of the coccyx was carried out two years after the accident.

SUMMARY.

1. In this series of 100 cases of fracture of the pelvis it is surprising to find that in 11 only were there any visceral complications.

2. The small number of cases in which visceral complications occur is not really so surprising as appears at first sight, when it is considered that quite a large proportion—due to their being run-over cases, where the pelvis is fractured and multiple visceral injuries are found at autopsy—are immediately fatal. The typical case of fracture of the pelvis of thirty years ago, when run-over accidents were not nearly so often fatal as at the present day, was caused by the wheel of a cart; while nowadays the non-fatal cases are caused by the comparatively small pneumatic wheel of the ordinary motor-car. The fatal cases of to-day are caused mainly through being run over by a lorry, a motor-bus, or a heavy motor-car.

3. There was no case of injury to the rectum.

4. There was no case of injury to the sacral nerves at the time of the accident and only one at a later date due to compression from excessive callus formation. This is not surprising, as the sacral foramina are roughly double the size of the nerves they transmit, and there is, therefore, ample room for some callus formation without encroaching upon the nerves.

REFERENCES.

[1] Vergorz, M., *Rev. de Chir.*, 1926, lxiv, 273.
[2] Wheeler, Sir W. I. de C., *Lancet*, 1925, ii, 313.
[3] Gardner, L. L., *Military Surgeon*, 1926, lviii, 392.

AN INCISION FOR DIRECT EXPOSURE OF THE WHOLE HUMERUS.

By GEORGE A. MASON,

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THE incision here described is of special use in those cases which require direct exposure of the whole humerus. It is also convenient in those more commonly occurring cases where only one segment of the bone seems to need exposure, because, if required, it can be easily extended upwards or downwards with relative impunity. A convenient position is to have the arm by the side, with the pronated and semiflexed forearm lying across the trunk. The line of the incision (*Fig.* 11), commencing above, extends from the clavicle immediately internal to the tip of the acromion. Passing down the arm along the outer border of the biceps, it terminates at the middle of the bend of the elbow. The incision is deepened (*Fig.* 12) to reach the deltoid, which is split in the direction of its fibres. This cleavage is approximately along the line of junction of the small clavicular and larger scapular portions of the muscle, and passes below through the apex of its V-shaped insertion. Continuing downwards, the brachialis is split in the direction of its fibres along the anterior 'crest' of the humerus, until the anterior capsular fibres of the elbow-joint are exposed below. No important structure is endangered if the incision is deepened through the periosteum and that membrane stripped from the bone by blunt dissection.

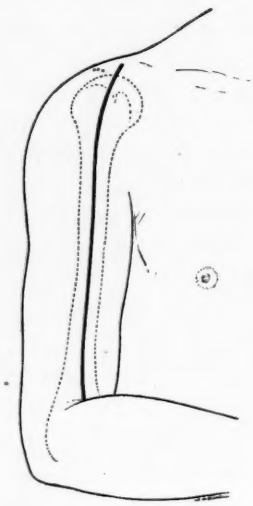

FIG. 11.
Line of incision.

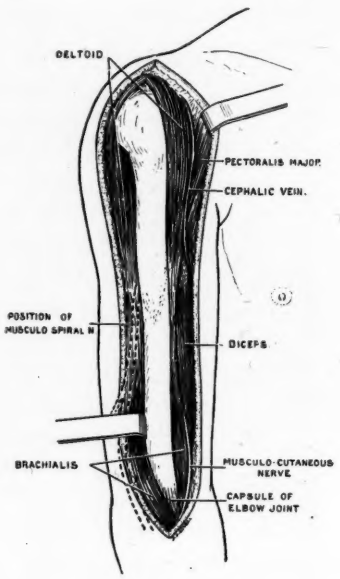

FIG. 12.
Direct exposure of humerus.

The following are some of the advantages of this incision :—

1. The cephalic vein is not interfered with, possibly a matter of importance in infected cases.

2. The musculospiral (radial) nerve is not seen, unless especially sought for amongst the muscular mass retracted outwards. It is closest to the bone

as it lies posteriorly in its groove. Even in this situation, and in normal subjects, the periosteum can be easily stripped away, carrying with it and protecting the nerve. This is, of course, even more marked in those cases where disease has thickened the membrane.

3. The musculocutaneous nerve in the lower part of the incision lies on the portion of the brachialis which is displaced inwards. Even when the incision is extended down to the elbow-joint this retraction of the muscle usually displaces the nerve out of harm's way.

4. That part of the brachialis which is external to the incision is said to be supplied by a branch from the musculospiral nerve.

5. The innervation of the anterior portion of the deltoid is by a special high branch of the circumflex nerve (*Fig.* 13). This is not endangered unless the incision is carried for approximately $1\frac{1}{2}$ in. above the level of the circumflex vessels as they cross the humeral shaft. If the incision is made at this high level, it is usually possible with care (as shown in *Fig.* 13) to recognize the nerve, mobilize it, and divide the periosteum deep to it. Even if this twig has to be divided, only a small (actually slightly less than a quarter) clavicular portion of the deltoid will be thrown out of action. The work of the paralysed part can be ' taken on ' by the adjacent fibres of the pectoralis major.

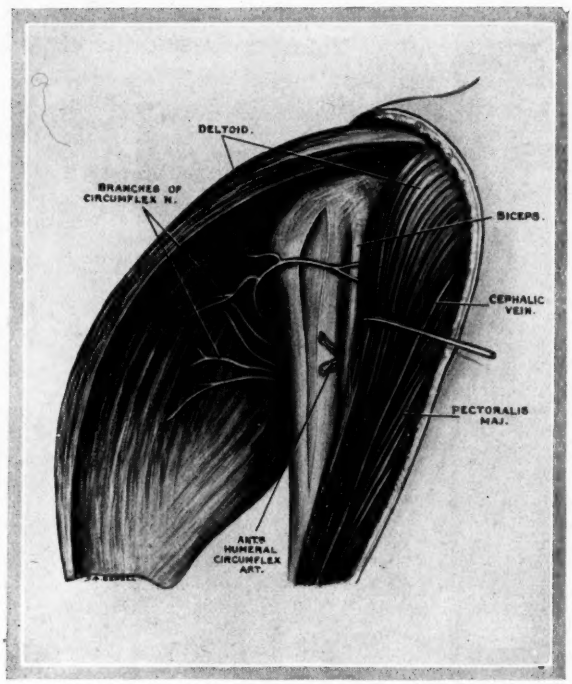

FIG. 13.—Innervation of right deltoid.

6. The incision is simpler than that described by A. K. Henry,[1] more especially as the difficulty and added risk of mobilizing and dealing with the clavicular chip, with the attached anterior fibres of the deltoid, are avoided, even when exploring the highest limits of the bone.

CASE REPORT.

The following is illustrative of a type of case in which this incision is useful :—

I. B., girl, age 11 years and 9 months, was admitted to hospital on Nov. 8, 1926, as an emergency case. She complained of a painful and swollen right arm. The condition was said to have been of a week's duration, and the severity of the pain had been such as to prevent sleep.

On Examination.—The child was very ill. The temperature was 102° and the pulse-rate 130 per minute. The whole of the right arm (shoulder to elbow) was glassy, swollen, and exquisitely tender. Although the swelling involved both the shoulder and elbow regions, the impression was formed that the inflammatory process was confined to the humerus. There was no evidence of pyæmic dissemination.

Operation.—Under open ether anæsthesia the right humerus was exposed by the incision as already described. The incision opened the periosteum and was carried at least an inch higher up the bone than the circumflex vessels, which were divided. Subperiosteal collections of pus were evacuated from almost the entire length of the humeral shaft. The exposed antero-lateral aspect of the bone was freely removed, pus liberated from the medulla, and the wound lightly packed. The child was critically ill for the next twenty-four hours, but after that soon commenced to improve.

Figs. 14. 15.—Functional results eighteen months after original operation.

Fig. 16.—Skiagram of humerus eighteen months after original operation.

During the next year several operations were performed—some for the removal of sequestra, whilst others were manipulations aimed at the restoration of joint movements. The wound finally healed in November, 1927.

Eighteen months after the original operation the child was examined and found to be in good health. At the shoulder-joint there was a normal range of movements. Extension at the elbow-joint was somewhat limited, but

flexion, supination, and pronation were good. *Figs.* 14, 15 illustrate the arm movements that were possible; the skiagram (*Fig.* 16) reveals the late condition of the bone. The division of the deltoid having been carried upwards for rather more than an inch above the level of the circumflex vessels, it is interesting to note that both portions of the deltoid (i.e., those on either side of the scar) reacted in an exactly similar manner to electrical stimulation.

My thanks are due to Professor R. Bramble Green and Dr. James Whillis, of the University of Durham College of Medicine, for their kind and generous provision of anatomical material and advice. Mr. Sewell's drawings are so clear that a written description is almost superfluous. Finally, there must be acknowledged the willing help and stimulating criticism which I have received from Professor G. Grey Turner.

REFERENCE.

[1] HENRY, A. K., *Brit. Jour. Surg.*, 1924–25, xii, 85.

DEVELOPMENTAL ENTEROGENOUS CYSTS AND DIVERTICULA.

(Based on a Hunterian Lecture delivered at the Royal College of Surgeons of England on Jan. 28, 1929.)

By ARTHUR EVANS,

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CASE REPORT.

A MALE, age 29, was admitted on Oct. 17, 1925, into Westminster Hospital complaining of 'pain in the lower part of the abdomen'.

In April, 1923, the patient first experienced his attacks of pain, which occurred at intervals of about three hours, for a period of seven days. Each attack consisted of griping pain over the whole lower abdomen lasting for about fifteen seconds; this was occasionally followed by pain in the epigastrium, lasting for a shorter period. The griping pain was severe and 'doubled him up'. The patient kept at his work during the whole of the week. The pain bore no relation to the ingestion of food or to exertion. During this week there was loss of appetite and malaise. There was no constipation or diarrhœa. The patient has always had a daily action of the bowels without taking drugs. A similar bout of these attacks occurred later in 1923, another in 1924.

In September, 1924, whilst lying in bed he experienced a strange sensation (described as 'heaviness') in the right side of the abdomen, and on examining the site found a 'lump' there. This lump has appeared many times since; it stays for a minute or less, then passes away—occasionally with a slight gurgle. If rubbed the swelling disappears at once; it is painless, and its presence seems to have no relation to the occurrence of pain.

In February, 1925, there was another series of painful attacks, occurring at intervals of about two hours. These were repeated in June and September. The patient was seen in the out-patient department and admitted into the wards with a diagnosis of tumour in the right side of the abdomen.

When I first examined the man I could detect nothing abnormal in the abdomen other than an easily palpable cæcum, and I wondered at the previous diagnosis. I saw the patient the following day and again could detect only this palpable cæcum; but as I watched the abdomen an obvious tumour developed in the line of the ascending colon. The anterior abdominal wall bulged forward over a circular area about four inches in diameter, the centre of which was raised about one inch above the level of the surrounding abdominal wall. On palpating this a tumour about the size of a cricket ball could be felt; in a few seconds the tumour softened and faded away. There was no doubt then that the 'lump' was a piece of gut, either the distended cæcum or a portion of the ascending colon.

Operation.—On opening the abdomen, the cæcum was seen to be larger than normal. About the middle of the ascending colon a strong, wide,

vascular band of adhesions was found extending from the outer to the inner border of the colon, somewhat constricting the gut. I divided this, along the line of the anterior tænia coli, and the constricted portion of the gut distended to the size of the neighbouring colon.

The vermiform appendix was, save for the terminal inch, adherent to the posterior surface of the cæcum, and was removed. On palpating the cæcum a cystic swelling could be felt in its interior; this was continuous below with the wall of the cæcum, but its upper end was free in the lumen of the gut. On opening the cæcum the condition shown in *Fig.* 17 was discovered. The cystic swelling was covered by the mucosa lining the gut. I endeavoured to enucleate the cyst through an incision made through the outer coats of the cæcum at its lowest extremity, but failed; the wall of the cyst was continuous with the muscular wall of the cæcum. In this attempt I opened into the cyst, and a milky mucoid fluid escaped. The cæcum and adjoining ileum were then excised and an anastomosis made between the end of the ileum and the side of the ascending colon.

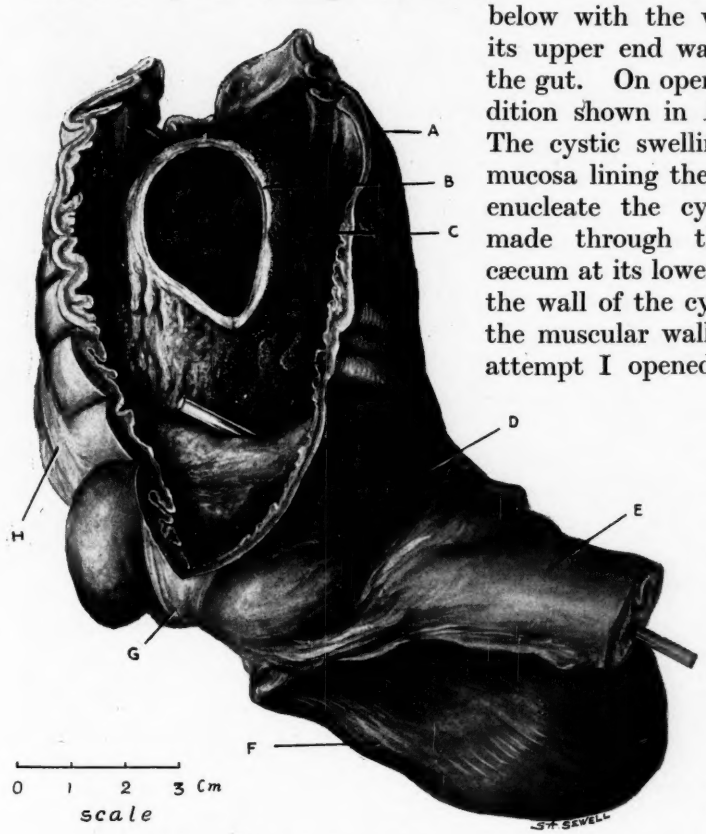


FIG. 17.—Developmental enterogenous cyst of the cæcum. The ascending colon and cæcum are laid open by a vertical section, the cyst being thus exposed. No part of the cyst is really extracæcal. A, Ascending colon; B, The site from which the section shown in *Fig.* 18 was taken; C, Intracæcal part of cyst; D, Ileocæcal junction; E, Ileum; F, Intramural part of cyst; G, Anterior tænia; H, Right tænia. ($\times\frac{2}{3}$.) (*See* Lotheissen's case, p. 64 and *Fig.* 47.)

The interior of the cyst was at once packed tightly with wool and the whole specimen placed in dilute formalin. As a result of this the cyst did not share in the general shrinkage process, and now presents the appearance of being partly extracæcal. This, however, is only apparent; the cyst is almost entirely intracæcal and partly intramural. The recovery was uninterrupted.

REPORT ON A SPECIMEN OF CYST OF THE CÆCUM.

BY SIR ARTHUR KEITH.

The relations and characters of this cyst are shown very clearly by Mr. Sewell's drawing (*Fig.* 17), which represents the specimen as now mounted in the Museum of the Royal College of Surgeons.

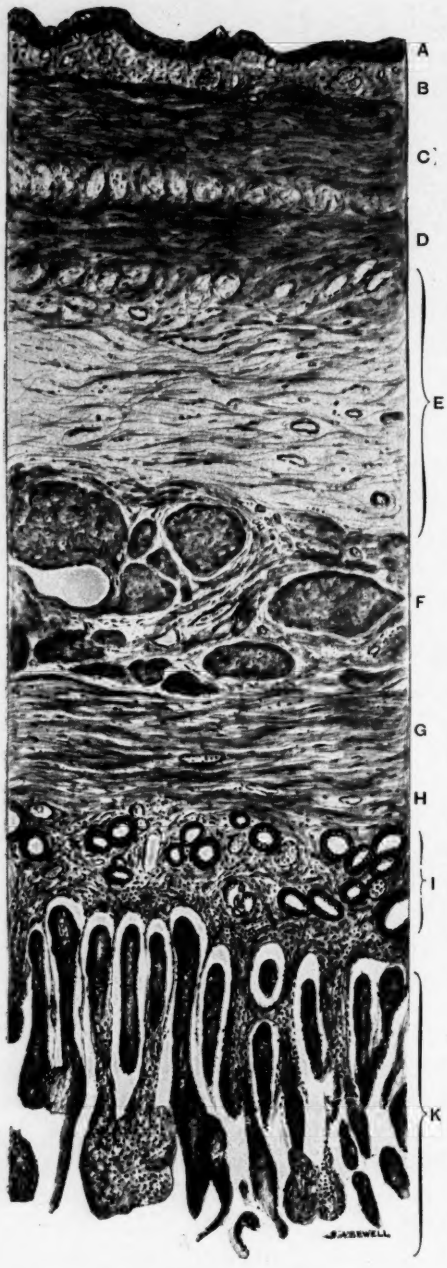


FIG. 18.—A section made of the cyst wall at the site shown in *Fig.* 17 B. A, Stratified epithelium; B, Submucous layer; C, Circular muscular coat; D, Longitudinal muscular coat; E, Loose fibrous tissue; F, Longitudinal muscular coat; G, Circular muscular coat; H, Submucous coat; I, Tubular glands—coiled ends of Lieberkühn's glands; K, Mucous coat.

The cyst is a large sausage-shaped structure, one part lying within the cæcum, the other extruding from the fundus of that organ. These two parts —extracæcal and intracæcal—are of about equal size. The total length of the cyst in its state as now exhibited is 14·2 cm. long, with a diameter of 5 cm. in its extracæcal part and 4 cm. in its intracæcal. Although part of the cyst is described as extracæcal, this is true of the appearance rather than of the reality.

The nature of the cyst, which is certainly developmental in origin, is brought out by the study of a section of its wall such as that represented in *Fig.* 18. The site of this section is indicated in *Fig.* 17 at the highest point of the intracæcal part of the cyst. The section shows that walls of both cyst and cæcum are included.

The cyst is lined by a stratified epithelium 30 μ thick, the basal layer of the cells being columnar, while the upper stratum—two or three cells in depth—shows elements which are cubical, flattened, or transitional in shape. Nowhere does the epithelium form glandular crypts, and yet in my opinion it must be regarded as representing the lining membrane of the alimentary canal. The distension of the cyst has probably led to flattening and atrophy of its epithelial lining.

The section shows, next to the epithelial lining, a dense submucous layer, only 40 μ in thickness; then comes a double coat of musculature, made up of circular and then longitudinal elements, the total muscular stratum being 400 μ thick. In most parts there are but two muscular layers, an inner circular and an outer longitudinal, but at certain points there are as many as four alternating layers. Outside the muscular coat of the cyst proper comes a stratum of loose fibrous tissue. Then come two muscular coats, a longitudinal and a circular, clearly representing the muscular coats of the cæcum, the fibrous tissue—between the muscular

coats of the cæcum and cyst—corresponding to the fused subperitoneal tissues of both structures. The combined muscular coats of the cæcum measure 700 μ in thickness, but in neither the cæcal nor the cystic musculature can the myenteric (Auerbach's) plexus be traced.

Then follow the submucous coat of the cæcal series (300 μ in thickness), and lastly the mucous coat, which is 900 μ in depth, being made up of elongated closely set tubular glands—glands of Lieberkühn. The muscularis mucosæ is very imperfectly separated, the reason of this being seen in *Fig.* 18. There it will be seen that at the bases of the tubular glands and the site of the muscularis mucosæ there occur coiled ducts laid open in circular and oval sections. There can be no doubt, I think, that these glandular structures represent the coiled ends of glands of Lieberkühn, but they do not occur as a continuous stratum, being absent in some parts. A section of a normal part of the cæcum shows a mucous membrane only 500 μ in thickness, against 900 μ over the cyst wall, while the muscular coat over a normal part of the cæcum has the same thickness as seen in this section. The section first examined reveals a double wall, one pertaining to cyst, the other to cæcum, and shows that the same strata are represented in each.

When a section of the extracæcal part (*Fig.* 17) of the cyst is examined the same strata are encountered as have been enumerated in the intracæcal part of the cyst wall—namely, a lining of transitional epithelium, a thin submucous layer, then a double muscular coat, and lastly one which represents peritoneum and subperitoneal tissue.

In *Fig.* 17 it is shown that the cyst is situated immediately behind the ileocæcal orifice; there the walls of cyst and cæcum fuse. The mucous lining of the cæcum is reflected on the intracæcal part of the cyst at a level which lies slightly below that of the ileocæcal orifice.

At first sight it looks as if the congenital cyst which occurs in the mesentery of the ileocolic angle, of which there is an excellent example in the R.C.S. Museum, No. 1220.01, and the cyst here described, could not be members of the same series. In both kinds the construction of the cyst wall is exactly the same; both represent developmental diverticula of the fœtal alimentary canal, the original opening into the canal becoming obliterated. A study of published cases brings to light forms which are transitional in position between the intramesenteric and the intracæcal forms. I therefore conclude that in the present case the cyst found within the cæcum is a variant of the more usual intramesenteric or ileocolic form.

Why the ileocolic angle should be the usual site at which congenital cysts occur we can give no satisfactory explanation. In no animal do we find any normal diverticular or glandular outgrowth formed at the ileocæcal junction, save the cæcal diverticulum, which in birds is double. There is no reason for regarding ileocæcal cysts as the representative of one half of a bifid cæcum.

ORIGIN.

There can be no doubt that cysts whose walls reproduce completely or incompletely the structure of gut, whether discovered in the wall of the gut, attached to the gut, or even more or less remote from the gut, must have

been derived from the gut. They are enterogenous cysts, and they originated as diverticula in the manner described by Keibel[1] and by Lewis and Thyng.[2] They are developmental enterogenous cysts.

Lewis[3] thus describes the formation of diverticula in the jejunum and ileum : The epithelium contains scattered vacuoles which develop in a characteristic manner. The vacuoles are first indicated by a concentric arrangement of the basal nuclei, and in this stage they have been described as 'buds' or 'pearls'. In the centre of such a bud a small cavity can often be detected (*Fig.* 19 *A*). In later stages the cavity communicates with the intestinal lumen, and the bud forms a knob-like basal projection (*Fig.* 19 *B*). These projections often have a somewhat constricted neck, and the overhanging portion may become asymmetrical, extending aborally along the intestine.

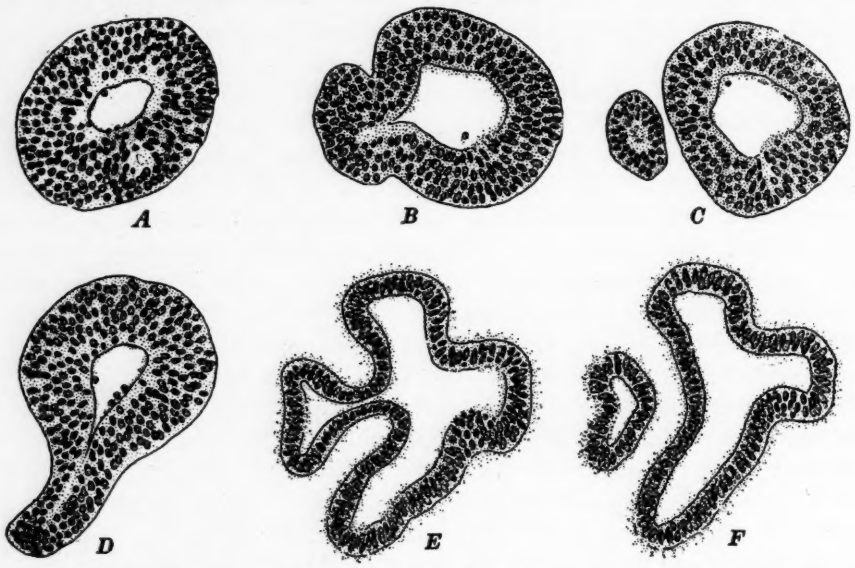


FIG. 19.—Cross-sections of the epithelial tube of the intestine, showing the development of diverticula. *A* to *D* from a 22·8-mm. embryo. *E* and *F* from a 30-mm. embryo. (× 130.) (*From Keibel and Mall*, ii, 384.)

Thus *Fig.* 19 *C* is an aboral section of the diverticulum shown in *Fig.* 19 *B*. Four of the thirty-two diverticula in a 22·8-mm. embryo project aborally. One diverticulum, longer than any of the others, extends laterally so that its tip penetrates the dense mesenchyma of the muscularis (*Fig.* 19 *D*).

Usually they are in close relation with the epithelial layer, and they cause no disturbance in the course of the muscular fibres. In older embryos (*Fig.* 19 *E* and *F*) the folded appearance of the epithelium renders the detection of the diverticula more difficult. It is probable that, by the enlargement of their necks, some of them are incorporated in the general epithelial layer. Others, however, retain their identity.

Summing up their examination of 24 pig embryos, Lewis and Thyng state that in pig embryos from 5·5 mm. to 14 mm. in length, one or two knob-like diverticula occur regularly in the duodenal region (*Fig.* 20). In embryos from 14 to 24 mm. the number of diverticula increases, and they are

distributed along the small intestine. None was found in the large intestine, except in the 32-mm. specimen, where a cluster of diverticula occurred near the ileum. The diverticula appear first in the duodenum and later in the lower portion of the small intestine. They begin as round knobs which may become elongated and detached from the intestine in the form of nodules, strands, or cysts. In later stages they acquire a lumen, and those found in the distal part of the small intestine appear as flask-shaped gland-like pockets. The rabbit embryos which were examined indicated that the diverticula begin to develop at 12 days. A 5-mm. rabbit of 12 days examined showed a pearl-like disturbance of the epithelial cells, suggestive of the later pockets. In a 7·5-mm. embryo of 13 days there was a round pocket with a lumen emptying into the intestine just beyond the duct of the dorsal pancreas. In this embryo there were also three pearls along the anterior limb of the intestinal loop. In a 14-day embryo there was a duodenal pocket near which was a detached epithelial nodule, containing a lumen. There were also four pearls along the anterior limb of the intestinal loop.

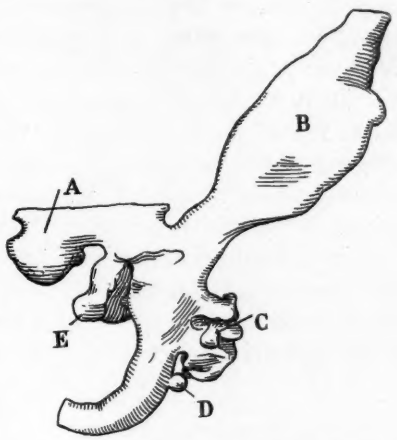


FIG. 20.—A reconstruction from a pig embryo of 5·5 mm., in which it is seen that the intestinal epithelium presents a knob just below the dorsal pancreas. A section through this is shown in *Fig.* 21 A. A, Vesica fellea; B, Stomach; C, Pancreas dorsale; D, Diverticulum; E, Pancreas ventrale. (*After Lewis and Thyng, 'American Journal of Anatomy'*, 1907–08, vii.)

A pig embryo of 17 mm. showed nine diverticula, most of which had a lumen communicating with that of the intestine. They began below the pancreas and were distributed along the duodenal region and anterior limb

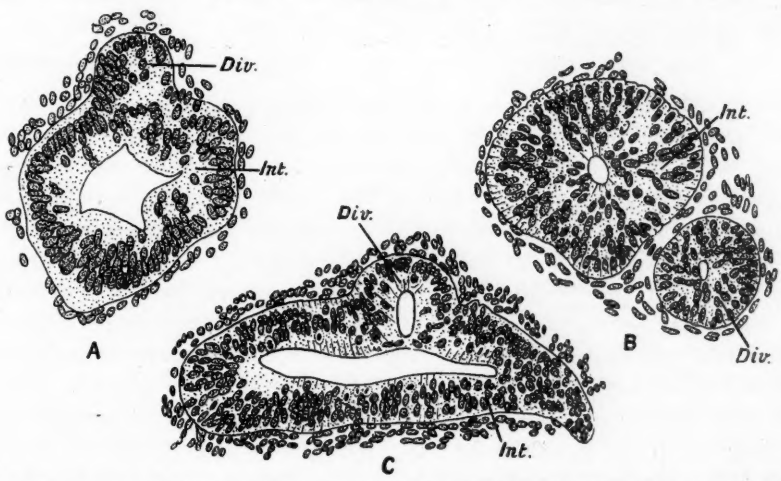


FIG. 21.—A, Section through the intestine (*Int.*) and diverticulum (*Div.*) in a pig embryo of 5·5 mm. (× 150.) B, Similar section from a human embryo of 13·6 mm. In adjacent sections the diverticulum was shown connected with the intestine. (× 150.) C, Similar section from a rabbit embryo of 11 mm. (14 days). (× 100.) (*After Lewis and Thyng, 'American Journal of Anatomy'*, 1907–08, vii.)

of the intestinal loop. Another had ten diverticula and one detached nodule. At 16½ days (18·8 mm.) there were six pockets, each with a lumen. The largest was in the duodenum, and others in the coiled part of the small intestine, separated from the first by a considerable interval. They did not decrease regularly in size towards the colon.

In a rabbit of 41·6 mm. a single pocket was found. It was shaped like a flat round flask, and set in the epithelium so that it produced only a slight bulging of the basement membrane. It had an oval lumen emptying into the intestine and was lined with smooth epithelium, contrasting with the much-folded intestinal layer which was in process of forming villi.

In a human embryo of 13·6 mm. Lewis and Thyng described a duodenal diverticulum (*Fig.* 22). Below the duodenal pocket there were indications of diverticula formation at twelve places along the small intestine. There were transitions between well-defined diverticula and slight irregularities of

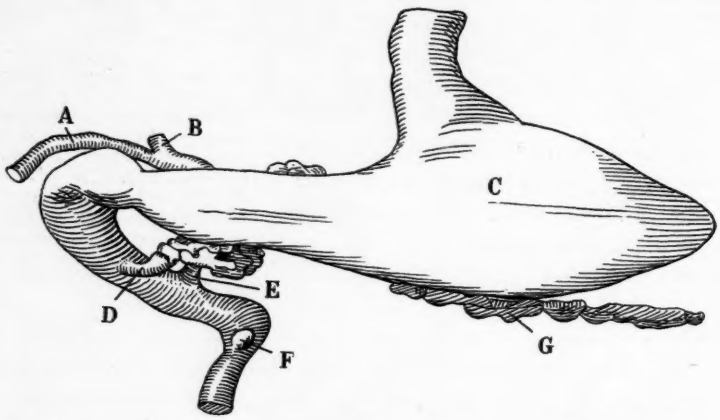


FIG. 22.—Reconstruction of a human embryo of 13·6 mm. showing a duodenal diverticulum. (× 35.) A, Cystic duct; B, Hepatic duct; C, Stomach; D, Ductus pancreatis dorsalis; E, Common bile-duct; F, Diverticulum; G, Dorsal pancreas. (*After Lewis and Thyng, 'American Journal of Anatomy'*, 1907–08, vii.)

the epithelium. In a human embryo of 23 mm. there were thirty-three well-developed diverticula along the small intestine; there were none in the ileocæcal region or in the large intestine. In a more advanced embryo the epithelium in the proximal part of the small intestine was greatly folded and had shrunk from the mesenchyme so that diverticula—even if present—would have been difficult to recognize; but within the umbilical cord the intestine was well preserved, and forty-eight diverticula were counted. In none of these human embryos were diverticula found along the large intestine and vermiform appendix. Originating in the manner described, it is clear that this abnormality may persist as a diverticulum, its lumen communicating with the lumen of the intestine, or it may become a completely closed sac, having no communication with the gut lumen. Lewis and Thyng described this process in a pig embryo. A 20-mm. pig embryo has twelve diverticula in that part of the small intestine which is preserved. There are none along the large intestine. The interesting feature of this embryo is a rather thin-walled epithelial cyst with a few rounded out-pocketings,

found just outside the muscularis of the duodenum, a short distance from the pancreas (*Fig.* 23). The intestine near by presents a solid cylindrical outgrowth which extends to the muscularis, but does not penetrate it. Undoubtedly this was formerly connected with the cyst, although at present it is not directed towards it, and is not where the cyst approaches to the muscularis. It appears that after the stalk became detached, the growth of the intestine carried it along and changed its direction.

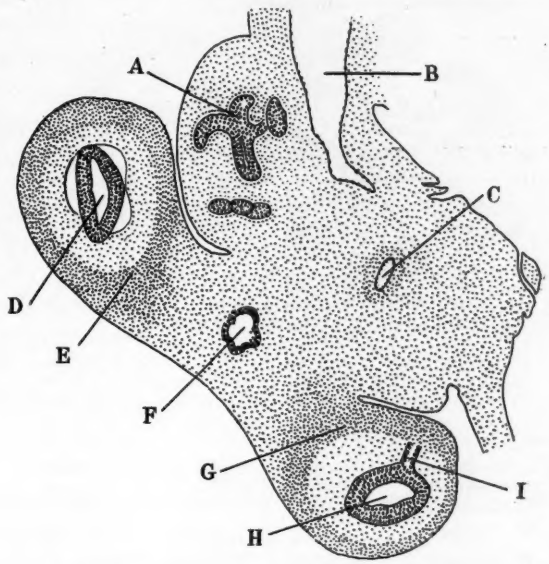


FIG. 23.—Section from a pig embryo of 20 mm. The loop of the duodenum is cut in two places. Midway between these is the cyst. The cyst comes in contact with the muscularis in the following sections. A, Pancreas; B Portal vein; C, Superior mesenteric artery; D, Duodenum; E, Muscularis; F, Cyst; G, Muscularis; H, Duodenum; I, Diverticulum. (× 30.) (*After Lewis and Thyng, 'American Journal of Anatomy'*, 1907–08, vii, 508.)

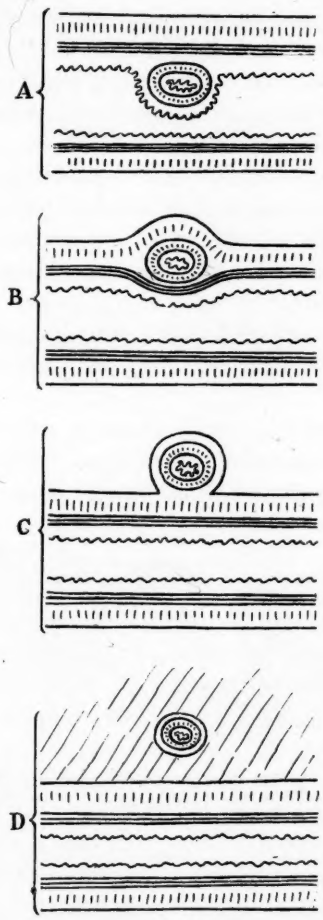


Fig. 24.—Enterogenous cysts: A, Submucosal; B, Intermuscular; C, Subperitoneal; D, Intramesenteric. ||| = Longitudinal muscular coat; ≡ = Circular muscular coat; ~~~ = Mucosa.

It is obvious, too, that the fully developed cyst may occupy any plane in the intestinal wall—submucosal, intermuscular, or subserous—and may occupy any segment of the gut periphery, whether antimesenteric, mesenteric, or any intervening site. Sometimes a subserous cyst situated on the mesenteric border of the gut loses its attachment to the gut wall and occupies a position between the layers of the mesentery more or less remote from the parent gut. (*Fig.* 24.)

From examination of histological sections it is apparent that cysts which at one time were subserous have become invaginated more or less completely into the lumen of the gut, may even have become pedunculated, carrying before them the coats of the gut. That this is the method of production of the case here reported is obvious

when we compare *Fig.* 25 with *Fig.* 18 and Sir Arthur Keith's histological report. Nearly all reported cases of ileocæcal cysts belong to this type of developmental cyst. (*See* case reported by Sir Arthur Keith[4] —R. C. S. Museum, Specimen No. 1220.01.)

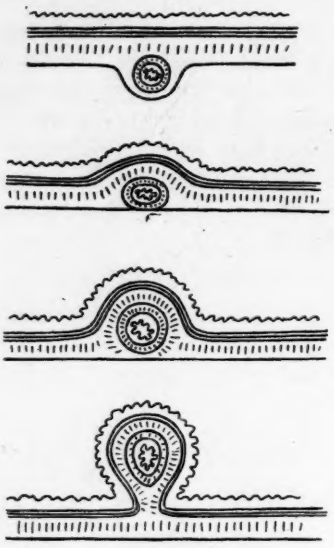


FIG. 25.—Diagram showing a subserous enterogenous cyst becoming invaginated into the lumen of the gut.

VARIATIONS IN THE STRUCTURE OF THE CYST LINING.

In a large number of recorded cases the structure of the cyst wall is complete, the mucosa, submucosa, and muscular layers being unmistakably intestinal. In others, however, there are great variations in the mucosal layer. We find "stratified epithelium", "cylindrical epithelium of varying heights", "a few epithelial cells", "atrophic mucosa", "tall columnar cells", "a somewhat stretched layer of columnar epithelium", "cubical epithelium with traces of submucosa", "flattened epithelial cells", "typical stratified epithelium with occasional cylindrical and cuboidal groups of cells", "stratified ciliated cells", "columnar ciliated epithelium", "a single layer of cuboidal epithelial cells", and even "the inner layer presents the structure of a serous membrane". Occasionally we find several varieties represented in the same cyst (*see* Miller's, Studgaard's, Hedinger's, and Gfeller's cases). The formation of villi may be complete or incomplete.

Many of the changes found in the lining of the cyst cavities can be accounted for by intracystic tension or by inflammatory changes. Others may be explained by the embryological development of the gut. *Fig.* 26 shows a section of the gastric epithelium from an embryo of 22·8 mm., in which it is seen that in places the epithelium is clearly simple, but elsewhere it may show several rows of nuclei, and is perhaps stratified. In embryos of 5·5 and 7 mm. the duodenum usually presents a well-defined round lumen bounded by a two- to three-layered epithelium. In slightly older embryos the epithelium proliferates and vacuoles are formed within it. Later the proliferating epithelium bridges and subdivides the original lumen, as seen in the section of a 10-mm. embryo (*Fig.* 27 *A*).

FIG. 26.—A section of the gastric epithelium from an embryo of 22·8 mm. (× 330.) (*From Keibel and Mall*, ii, 372, *Fig.* 275.)

Occasionally the masses of cells surrounding the vacuoles produce local bulgings of the basement membrane. At 22·8 mm. (*Fig.* 27 *B*) the

out-pocketings are so numerous that the epithelium appears folded, and mesenchyma has begun to extend inwards between the pockets or folds. In sections the vacuoles cannot be distinguished from the main lumen. At 30 mm. (*Fig. 27 C*) the vacuoles begin to become confluent so that a central lumen is re-established. "The projections between the vacuoles remain as the foundations of villi." In embryos from 30 to 60 days the duodenal lumen is normally more or less completely obliterated.

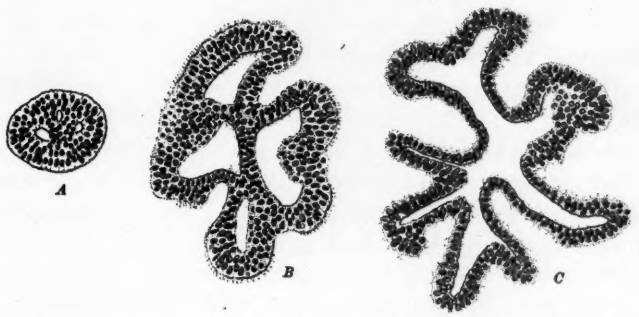


FIG. 27.—Cross-sections of duodenal epithelium. (× 85.) *A*, At 10 mm. The upper cavity is a vacuole, the two lower ones are part of the original lumen. *B*, At 22·8 mm. C, At 30 mm. (*From Keibel and Mall*, ii, 382.)

Kollman[5] states that the epithelium of the developing gut undergoes a regular progression from simple cuboidal to simple cylindrical, and then to stratified epithelium; from which finally develops the permanent layer of simple cylindrical epithelium, which in the respiratory tract is ciliated. To account for the diversity of cells found lining enterogenous cysts it has been suggested that the sequestered group of cells may retain the characteristics shown by its parent at the time of separation. This is a possibility; but a much more probable explanation of the varied types of epithelium found lining certain of these developmental cysts and diverticula is afforded by a study of the epithelial misplacements of the intestinal tract. We know that the cells lining the whole primitive intestinal canal are morphologically identical, and that later they become differentiated into the squamous epithelium of the œsophagus, the glandular elements of the stomach, duodenum, small and large intestine, the mucosa of the gall-bladder, and the parenchyma of the liver and pancreas. Nicholson[6] has shown that these fully differentiated cells may de-differentiate when chronically inflamed, and eventually re-differentiate into the cells typical for that particular region, gastric cells in the stomach, intestinal cells in the intestine, gall-bladder mucosa in the gall-bladder, etc. On the other hand, such de-differentiated cells may become re-differentiated, but in a direction other than that of the normal embryonic development. Thus, Nicholson reports the frequent occurrence of gastric glands in the mucosa of gall-bladders as a result of cholecystitis, and has described the presence of gastric glands in a tuberculous ulcer of the colon, and of newly-formed pyloric glands in tuberculous granulations of the vermiform appendix, the differentiation under these pathological stresses being atypical or heterotopic. Along the same lines Nicholson would explain the presence of developmental heterotopic tissues (cardiac glands in the œsophagus, intestinal glands in the stomach, squamous epithelium in the gall-bladder, squamous epithelium in a pancreatic duct, etc.), "since there is good evidence [Meyer[7]] that everyday pathological processes take place even in the embryo and these must surely alter the environment of the cells."

If, then, abnormal differentiation of cells occurs when the surrounding conditions are abnormal—in other words, when the environment is altered—it is not to be wondered at that the cells lining fœtal diverticula and cysts sometimes differentiate abnormally and give rise to the many varieties of epithelium which have been found lining these structures. We shall later refer to instances in regard to which little doubt can be entertained that heterotopic tissue has occurred in and been occasioned by developmental diverticula; sufficient here to note the fact that in the normal processes of development when diverticula form from the primitive digestive tract, some subtle change takes place in the endoderm lining them, and lung or pancreas, liver or gall-bladder results.

DISTRIBUTION.

Although most of the congenital diverticula have been discovered in the duodenal region and most of the congenital intestinal cysts in the ileocæcal region, there is no reason why they—cysts and diverticula—should not develop in any part of the intestinal tract; and a study of the literature reveals the fact that they do occur over a wide distribution: in the œsophagus, stomach, duodenum, jejunum, ileum, ileocæcal region, vitello-intestinal tract, vermiform appendix, and sigmoid.

J. W. Larimore and Graham[8] state that in 3446 cases of complete X-ray examinations of the intestinal tract they found diverticula in 105 cases: 9 of the œsophagus, 3 of the stomach, 19 of the duodenum, 3 of the jejunum, and 71 of the colon.

ŒSOPHAGUS.

R. G. Hebb[9] demonstrated a specimen which he had removed from a female, age 31, who died of heart disease at Westminster Hospital. The cyst, the size of a pigeon's egg, was attached to the œsophagus about an inch and a half below the left lobe of the thyroid body, lying in the angle between the œsophagus and the trachea, with the recurrent laryngeal nerve passing over it. There was no communication, and no naked-eye evidence of previous association with the œsophagus. Microscopical examination of the wall of the cyst shows that it is composed chiefly of muscular tissue, and that it is lined by a mucosa. The muscular tissue is striped and unstriped; externally there is a layer of striped muscle, next to this a single layer of unstriped muscle, cut transversely, and next internally are several layers of unstriped muscle, the fibres being arranged parallel to their long axes and to the outline of the cyst. The mucosa consists of two to three layers of cells, the superficial ones being columnar ciliated epithelium. Compare with this a section made of the œsophagus of a negro child by Lewis[10] (*Fig.* 28).

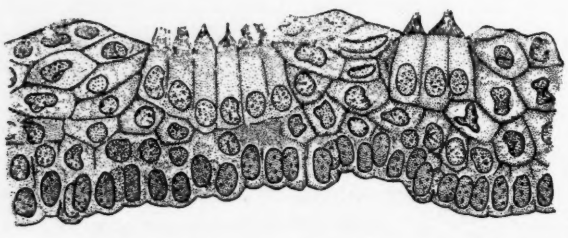


FIG. 28.—Section of the œsophageal epithelium of a negro child at birth, showing many ciliated cells. (× 600.) (*From Keibel and Mall*, ii, 361.)

Wyss[11] described a tumour found in the body of an adult. It was situated on the posterior aspect of the œsophagus, about one inch above the cardia, and was as big as a medium-sized apple. It contained a gelatinous, milky-coloured fluid, in which were many ciliated epithelial cells. The inner lining, 1 mm. thick, consisted of degenerated ciliated epithelial cells; the other layers consisted of connective tissue and muscular tissue.

See also Roth's case, p. 49 and *Fig.* 37.

STOMACH.

Gardiner[12] described a stomach, the posterior surface of which is seen in *Fig.* 29. The cardiac end was the size of a tennis ball, and its capacity was 56 c.c. The stomach then became constricted, and beyond the constriction the pyloric half of the stomach resembled a tube. In the furrow at the constriction was an accessory pancreas; the pancreas was continued through the posterior wall of the stomach and terminated in a papilla just below the lesser curvature. Opening off from the posterior wall of the pyloric tube was a large sacculation, like the dilated finger of a glove, lying parallel with the greater curvature of the stomach. The communication between the pyloric portion of the stomach and the diverticulum comfortably admitted the middle and index fingers. The main pancreas was found in its usual position and showed no anomalies.

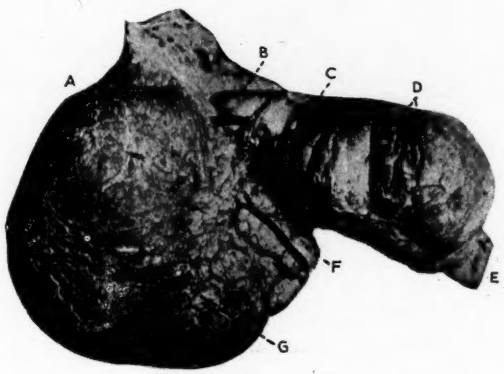


FIG. 29.—The posterior surface of the stomach, showing a large diverticulum of the pyloric portion, and an accessory pancreas. A, Cardia; B, Location on the mucous membrane of the papilla for the opening of the excretory ducts; C, Epiploic vessels; D, Diverticulum; E, Pylorus; F, Accessory pancreas; G, Fundus of stomach. (*From the 'Journal of the American Medical Association'*, 1907, xlix.)

A. W. Pritchard[13] operated on a boy, age 15, who from infancy had been subject to attacks of 'wind colic'. The attacks of abdominal pain and swelling had been occurring irregularly about every two months, sometimes with and sometimes without diarrhœa. For the ten days prior to the operation he had been kept in bed and suffered from six violent attacks with diarrhœa. The boy stated, "The lump comes up with pain that makes me groan; the lump goes, and then the pain passes off." "On opening the abdomen a huge mass was found pushing forward the transverse colon. It looked like a huge intussusception, or a hernia of the stomach between the layers of the mesocolon. In fact when I had incised the peritoneum over it, it was so like a stomach that I prolonged my skin incision to prove that the stomach was in its normal place. I opened the cyst and about 15 oz. of fluid were let out. I then proceeded to free it from its attachments, stripping off the peritoneum with considerable difficulty and hæmorrhage. A pedicle was found at the vertebral attachment and tied off." The specimen was shown at the Pathological Society of Great Britain and Ireland, and reported on thus: 'Microscopically the cyst wall was composed

of gastric mucosa. The glandular layer showed an excess of mucoid-forming cells, but otherwise the normal appearances were not departed from. The submucous, muscular, and serous layers were all represented, and were typical.' "

Ahrens[14] reported an operation on a female 17 years old in whom he found and removed a cyst containing four litres of thick reddish-brown fluid. The cyst was situated behind the peritoneum on the right side of the abdomen. In appearance it suggested an hour-glass stomach and 26 cm. of small intestine. Microscopical examination of the cyst wall revealed a structure identical with that of a stomach and small intestine, save that the mucosa in different sections consisted of stratified and cuboidal cells, stratified ciliated cells, tall columnar, and flat cells. The fluid in the cyst was weakly acid, and digested egg albumen on the addition of hydrochloric acid. There were multiple ulcers in the pseudo-stomach.

Fig. 30 is a drawing from a specimen in the Westminster Hospital Museum (No. 455.A). In the pyloric portion of the stomach immediately

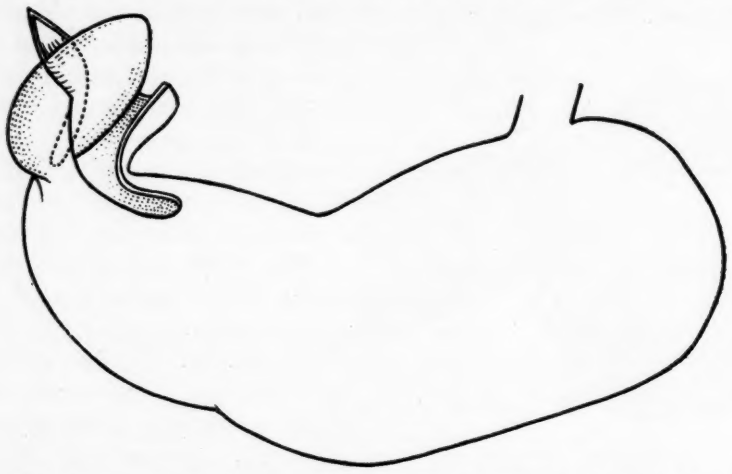
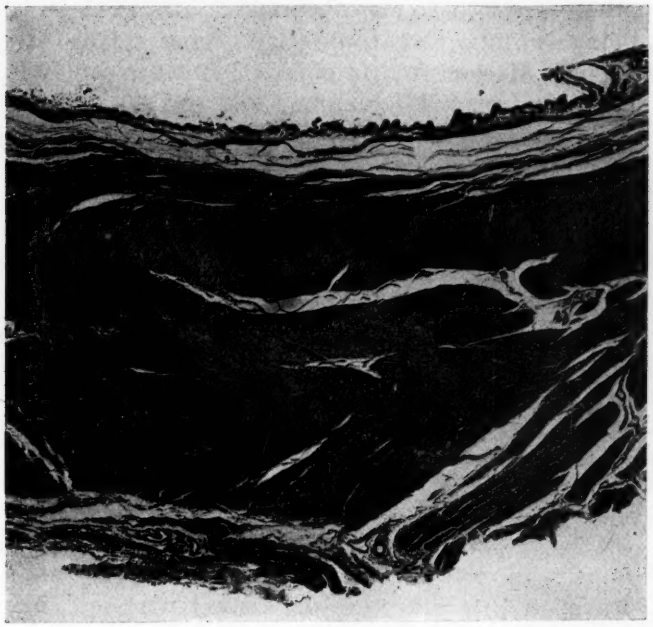


FIG. 30.—Developmental enterogenous cyst in the pyloric end of the stomach, immediately adjacent to the pylorus. (*Westminster Hospital Museum*, No. 455.A.)

adjacent to the pylorus is a firm-walled cyst 2 × 1 in. The reflection of the gastric mucosa on to the anterior and outer surface of the cyst is shown in the drawing; elsewhere the attachment of the tumour is indicated by the dotted line. " The stomach is not dilated, nor is the pylorus distorted, showing that no obstruction was caused. From a child 6 months old, who died from perforation of a typhoid ulcer in the ileum. The cyst contained glairy fluid." A recently cut section of the cyst wall where it protrudes into the lumen of the viscus shows it to be covered by pyloric mucosa; this lies upon a muscular coat. The cyst is lined by " flattened gland cells ".

There is in the Royal College of Surgeons Museum a pedunculated diverticulum $2\frac{3}{4} \times 1\frac{1}{2}$ in.; its wall is $\frac{1}{5}$ in. thick, and the lining mucous membrane exhibits rugæ resembling those of a normal stomach. Microscopical examination of the wall of the diverticulum shows the general structure of a stomach. The central canal in the pedicle is lined by a mucosa consisting of short glands which are mucus-secreting throughout their length;



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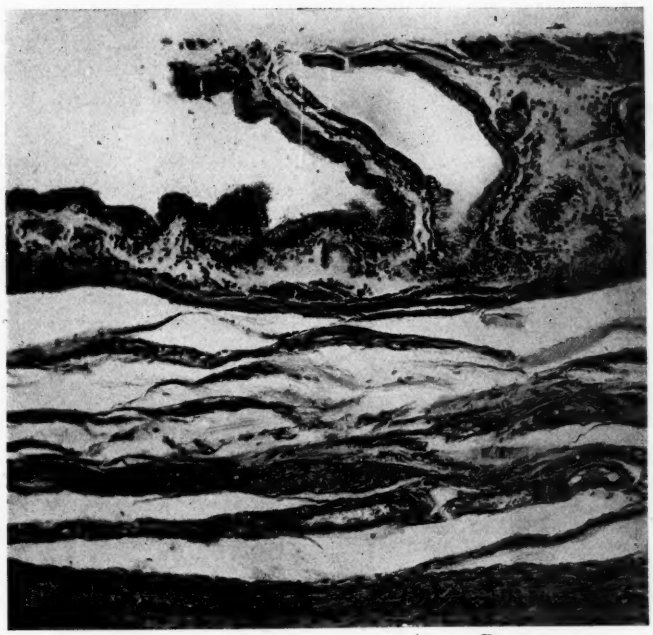

× 75

FIGS. 31, 32.—Sections of developmental enterogenous cyst, enucleated from the wall of the stomach and from the adjacent pancreas. (*Westminster Hospital Clinical Reports*, 20–1116; Section No. 3884.A.)

the submucous layer is only slightly marked, and a muscularis mucosæ not recognizable; there are two layers of muscle; outside these is a broad layer of dense and highly muscular connective tissue. This diverticulum was removed by Mr. Neil Sinclair from a child 4 months old. It lay in the angle formed by the duodenum and jejunum. The pedicle was directed upwards across the anterior surface of the termination of the duodenum; it passed through a hole in the transverse mesocolon, and around this aperture the mesocolon was much thickened. The diverticulum contained blood and mucus. There was no torsion of the pedicle.

Figs. 31 and 32 show low- and high-power views of a section through the wall of a cyst removed by Mr. Rock Carling. The patient was a female, age 39. The cyst, the size of a walnut, was embedded partly in the pancreatic substance and partly in the muscular wall of the stomach. To remove it, it was necessary to incise the muscular wall of the stomach on the upper aspect of the cyst. The cyst contained a few minims of turbid fluid. It possessed a fibromuscular coat 4 mm. thick, and was lined by tall columnar mucus-secreting cells, by low cuboidal cells, and by flattened cells.

DUODENUM.

Many instances of congenital intestinal diverticula of the duodenum have been recorded, particularly in the second portion. Now that screen examinations after a bismuth meal are so constantly made, duodenal diverticula have ceased to be looked upon as great rarities.

Spriggs[15] found that the situation of the diverticula in the reported cases of Buschi, Bauer, Wilkie, Bosch, Ritchie, and McWhorter was as follows: Out of 57 cases: 11 in the first part; 2 in the first and second parts; 41 in the second part; and 3 in the third part of the duodenum.

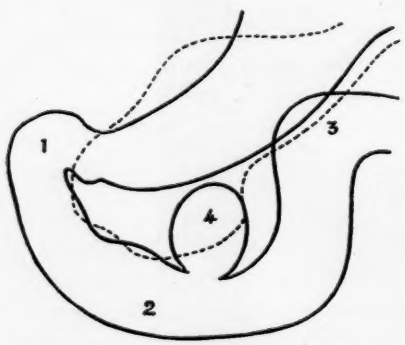

FIG. 33.—Diverticulum of the duodenum. 1, First part of duodenum; 2, Transverse duodenum; 3, Duodenojejunal angle; 4, Duodenal diverticulum. Pancreas is shown in dotted outline. (*After Jackson, 'Journal of Anatomy and Physiology'*, 1902, xlii, 219.)

C. M. Jackson[16] reported a case of duodenal diverticulum which was found post mortem in a man, age 50, who had died of pneumonia. "It extends upwards from the upper wall of the transverse duodenum (*Fig.* 33). The sac measures about 3·5 cm. in the vertical direction, 3 cm. in the transverse width, and 2 cm. antero-posteriorly (being deepest in this direction in the lower part of the sac). The neck of the sac is constricted, the aperture of communication with the duodenum measuring about 5 mm. in diameter. The diverticulum is in contact, posteriorly, with the aorta and vena cava. Anteriorly, it is in contact with the superior mesenteric artery and vein below, and with the posterior surface of the head of the pancreas above. The wall of the sac is thin (0·7 to 0·8 mm.), and in general resembles the neighbouring duodenum in structure. It is lined by mucous membrane, somewhat reduced in thickness, and is limited externally by a thin fibrous tunic. Between these

is a muscular coat, only 0·1 to 0·15 mm. in thickness, but everywhere distinct." *Fig.* 33 should be compared with *Fig.* 22—a drawing by Lewis and Thyng of a duodenal diverticulum in a 13·6 mm. embryo.

Specimen No. 6283.1, Royal College of Surgeons Museum, shows two diverticula of the duodenum (*Fig.* 34). Immediately adjacent to the bile papilla is a round aperture in the wall of the bowel, measuring about half an inch in diameter, and leading into a diverticulum of somewhat pyriform shape, and $1\frac{3}{4}$ in. long. The wall of the pouch consists of the mucous and submucous coats of the bowel. On the opposite side of the bile papilla is a small aperture leading into a pouch the size of a pea. The patient, a man, age 72, died of a strangulated hernia. There were several small diverticula in various parts of the small intestine.

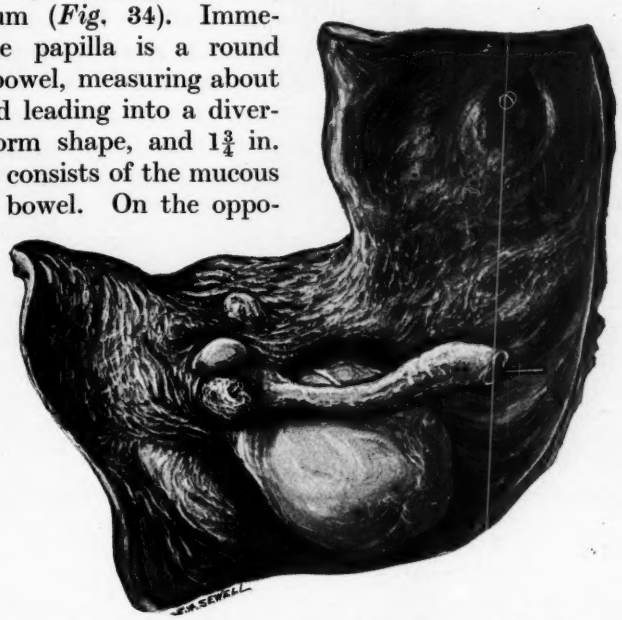

FIG. 34.—Two diverticula of the duodenum, the openings into which are situated one on each side of the bile papilla and immediately adjacent to it. (*R.C.S. Museum*, No. 6283.1.)

In the Westminster Hospital Museum No. 455B is a large diverticulum of the first part of the duodenum. Its vertical diameter is $1\frac{3}{4}$ in., its transverse diameter $1\frac{1}{4}$ in., and its depth about 1 in. Microscopically the lining of the diverticulum was found to be normal mucosa, and the muscular coats were hypertrophied (*Fig.* 35).

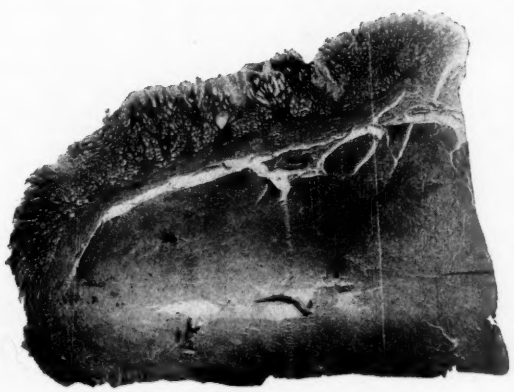

FIG. 35.—Section through the wall of a duodenal diverticulum, showing a normal mucosa, and hypertrophied muscular coats. (*Westminster Hospital Museum*, No. 455B. *Section* No. 199.)

Roth[17] records a case occurring in a newly-born male child who lived but a few minutes; the abdomen was greatly distended; there was a large thin-walled cystic tumour, lying on the stomach and duodenum; in the illustration the tumour is shown displaced downwards (*Fig.* 36). It will be noticed that the tumour is in two parts, A and B. The two sacs were quite separate, but they had a common pedicle in the region of the pancreas and the duodenum. Dissection of this region revealed a short pipe-like connection 1 cm. long between the two cysts. This intercommunicating channel was lined by cylindrical epithelium of varying heights. No connection was discovered between the cysts and the lumen of

the intestinal canal, but at the posterior surface of the pedicle was a layer of unstriped muscle which was thought to have been torn from the wall of the duodenum. Sections of the cyst wall revealed all the layers of the intestinal wall; in places the mucosa was thin. C is an enterogenous cyst in the right posterior mediastinum, situated close to the œsophagus, and evidently derived from it. Its wall had a structure closely resembling that of gut, save that the cells of the mucosa were flattened from intracystic pressure.

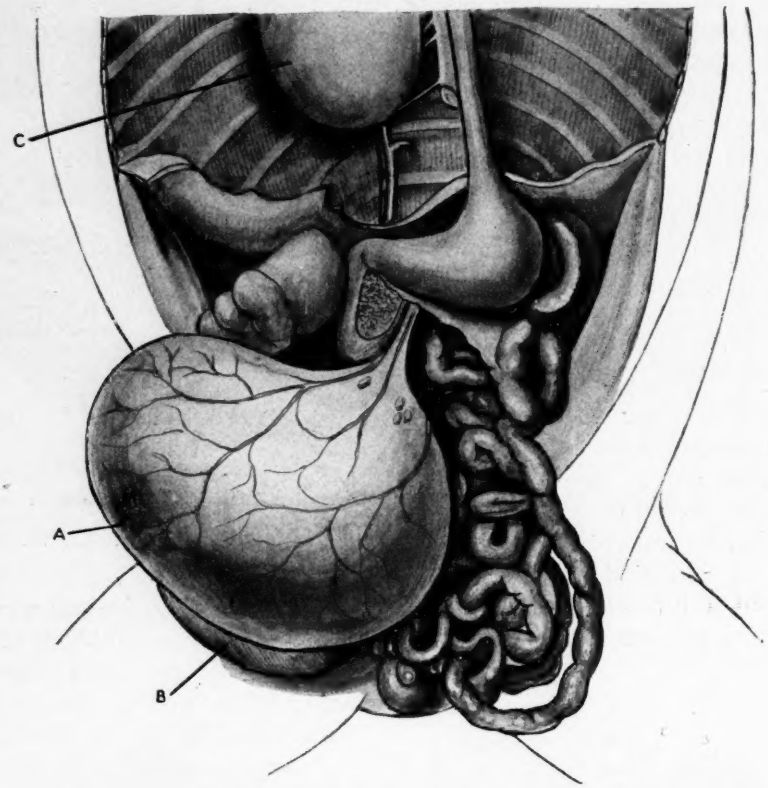

FIG. 36.—A and B, Developmental enterogenous cyst, connected with the third portion of the duodenum. C, Cyst in right posterior mediastinum, derived from the œsophagus. (*After* '*Virchow's Archiv*', lxxxvi, *Taf.* xv.)

Oliver Waugh[18] reported a cyst connected with the second portion of the duodenum, found at an operation for persistent vomiting in a child 19 days old. The cyst, the size of a tangerine orange, was retroperitoneal, and was intimately connected with the posterior wall of the second portion of the duodenum. The gut being tightly stretched over the cyst had occasioned the obstructive symptoms. The cyst wall possessed well-marked inner circular and outer longitudinal muscular coats. I think there can be no doubt that the case, like Roth's, is a developmental enterogenous cyst, derived from the second part of the duodenum.

Sanger and Klopp[19] described the condition found in the abdomen of a newborn child (*Fig.* 37). The labour was very difficult and protracted, and

the child died before the delivery was completed. The viscera were transposed. The heart occupied the right side of the chest. The stomach was situated in the right upper abdomen. The liver filled the left hypochondrium. "Instead of the spleen, in the right hypochondrium were 16 completely isolated lobules of spleen tissue—together forming a mass equal to that of the normal spleen." The abdomen contained five cysts—their situation being

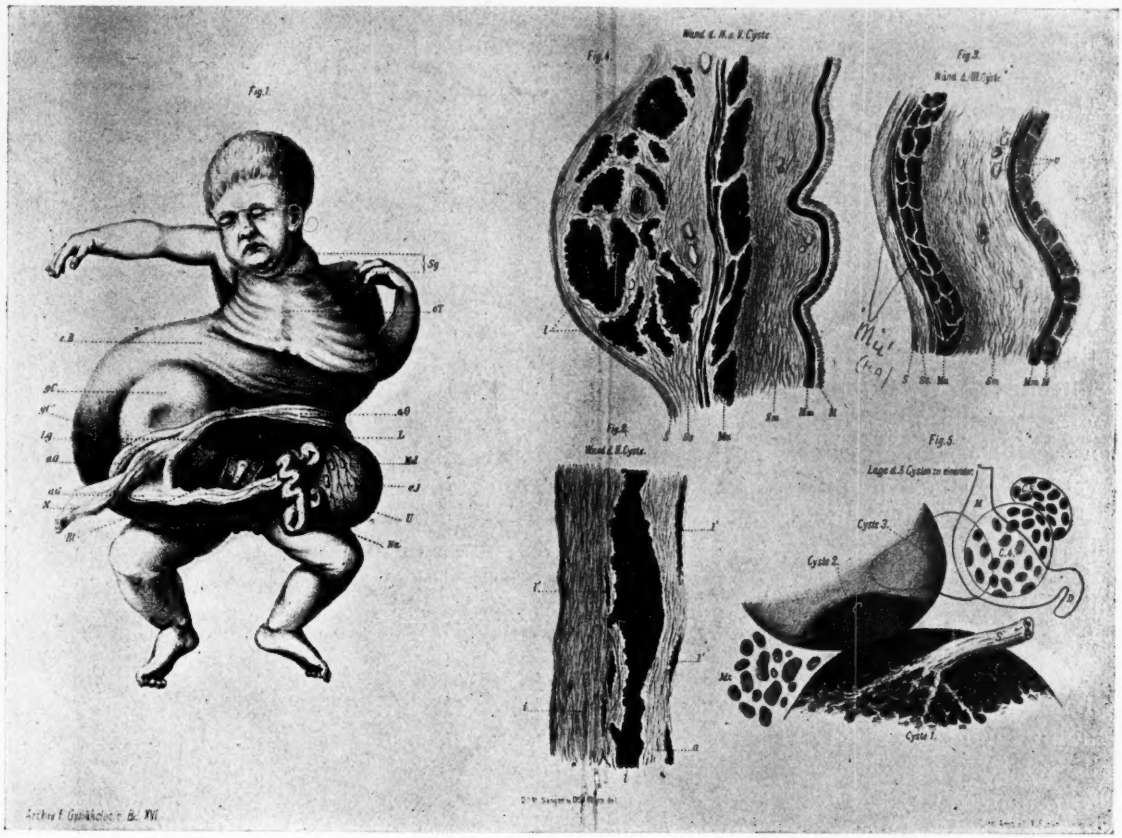

FIG. 37.—Abdomen of a new-born child in which there were five developmental enterogenous cysts. The walls of these contained liver substance.

Fig. 1.—General appearance of the child after opening the abdomen. *gC* and *gC'*, The largest of the cysts; *Lg*, Scattered nodules of liver substance; *L*, Right lobe of liver, in the left hypochondrium; *Bl*, Bladder; *N*, Umbilical cord; *U*, Urachus.

Figs. 2, 3, 4.—Sections of the various cyst walls. *M*, Mucosa; *Mm*, Muscularis mucosæ; *Sm*, Submucosa; *Mu*, Muscular coats; *l*, *l'*, Liver substance; *i*, Connective tissue.

Fig. 5.—Relation of the five cysts to each other. *Mz*, Lobules of spleen.

(*From 'Archiv f. Gynäkologie'*, 1880, xvi, 415, *Taf.* vii.)

shown in ***Fig.* 37** [*Fig.* 5]. The largest cyst was the size of the child's head; its circumference was 30·5 cm. The anterior surface of this cyst over an area about 7 cm. in transverse diameter was composed of a thin layer of a dark brown substance 1·5 to 2 mm. thick. This was subdivided into small lobules. This substance looked like liver, and microscopical examination proved it to be so. For some distance from the main mass of liver substance small

isolated masses could be seen accompanying the vessels which ran in the wall of the cyst. The pedicle of the cyst was attached about the centre of the mass of liver substance, and this pedicle ran upwards towards the duodenum. I regret that the exact attachments of this pedicle are not described. The cyst contained about 300 c.c. of dark yellow mucoid fluid in which bile was present. When microscoped the fluid was found to contain flattened cells and low cubical epithelial cells. The wall of the cyst consists of an outer peritoneal surface lined by closely interwoven connective-tissue fibres and some compressed and atrophied unstriped muscle fibres. Immediately above this cyst was a second, 23 cm. in circumference. These were adherent to one another over an area the size of a shilling piece—but there was no communication between the two cavities. The whole surface of this second cyst was covered by a layer of liver tissue, thickest where the two cysts were opposed. The structure of its wall is shown in ***Fig.* 37** [*Fig. 4*], in which it will be seen that a layer of liver structure lies between the inner and outer connective-tissue planes. On following the pedicle of the first cyst towards the duodenum a third cyst was found, a little bigger than a walnut. The wall of the cyst was $1\frac{1}{2}$ mm. thick, and its structure was identical with that of the intestinal wall, as shown in ***Fig.* 37** [*Fig. 3*]: a mucosa possessing no Lieberkühn's glands, a well-developed muscularis mucosæ, a submucosa, then a well-developed circular muscular layer, a longitudinal muscular layer, subserous layer, and peritoneum. Above this and connected with it, and behind the stomach, was a fourth cyst, smaller than the third. Its outer surface was covered with tiny masses of liver substance of varying thickness. The structure of the wall (***Fig.* 37**) [*Fig. 4*] is identical with that of gut, but there are islets of liver tissue in the subserosa. Above this cyst is a fifth, which macroscopically and microscopically is identical with the cyst last described.

Sanger and Klopp came to the conclusion that the first cyst was developed from an accessory liver, and that the primitive gall-bladder had undergone a cystic degeneration; that the second cyst must have been developed from the bile-duct of the accessory liver, and that this also had undergone cystic degeneration; and that cysts 3, 4, and 5 were intestinal cysts. That these are enterogenous cysts there can be no doubt. The occurrence of liver cells in their walls is of great interest, and I have come across no other cyst of intestinal origin showing this structure. Seeing, however, the fairly common occurrence of pancreatic tissue in diverticula, it was only to be expected that liver substance would be found in enterogenous diverticula and cysts; for with our knowledge of the heteromorphoses of the intestinal tract, it is not surprising that the cells lining diverticula of the fœtal entoderm in the vicinity of those buds which grow out and form the liver should themselves display the same power and differentiate into liver cells. Although the structure of cysts 1 and 2 only incompletely approximate to that of the intestinal wall, still the presence of a serosa, connective tissue, compressed muscle fibres, and the occurrence of shed epithelial cells (flattened and cubical) in the fluid contents of the cysts, is sufficient justification for the assumption that these too belong to the group of developmental enterogenous cysts.

JEJUNUM.

William Major,[20] under the heading "Constriction of the Jejunum by a Congenital Prolongation of its Coats", describes a case of intestinal obstruction in a pregnant woman, age 37. The site of obstruction was between three and four inches from the duodenojejunal flexure. At this point a diverticulum arose from the anterior surface of the jejunum, encircled the gut, and formed a knot which could not be untied.

Helverstine[21] found at a post-mortem on a male, age 70, who died of uræmia consequent on hypertrophy of the prostate, 58 diverticula in the first 95 cm. of the jejunum. These varied in size from 2·5 × 2 cm. to 0·5 × 0·3 cm. They were all situated along the mesenteric border of the jejunum. The large diverticula were near the duodenum, and diminished in size as the distance from the duodenum increased. Helverstine gives a summary of 27 cases of diverticula of the jejunum reported in the literature. Commenting on the condition he says: "Such diverticula in the beginning of their formation are of the true type, containing all the coats of the intestinal wall, as in the case of the smallest pockets found in my specimen and in the specimen described by Klebs.[22] Later, due to progressive atrophy, now accelerated by increased pressure from within, the muscle fibres disappear and a large diverticulum of the false type is found."

Braithwaite[23] and J. Allan Berry[24] have reported cases of multiple diverticula of the jejunum. Braithwaite's specimen is in the R.C.S. Museum (No. 6377.1).

Buchwald[25] reported a case in which he found two cystic tumours, one 10 cm. long, the other 17 cm. long, 4 cm. apart, arising from the jejunum about 50 cm. from the duodenum; these communicated with the gut by a small opening. Microscopical examination showed the diverticula lined by atrophic mucosa; the walls consisted mainly of connective and fibrous tissue, with a few muscular fibres.

John L. Hunter[26] described a cyst found in a child who died when seven days old. Lying along the mesenteric border of the jejunum and between the two layers of the mesentery were two cystic swellings. The jejunum was stretched transversely upon these swellings so that its lumen was slit-like in cross-section. The cysts were found to communicate with one another at the intestinal border of the mesentery by an opening 1 cm. in diameter. One loculus measured 55 × 43 mm., the other 68 × 41 mm. The walls contained all the elements found in the wall of the intestine, but the most careful dissection showed no communication between the lumen of the cysts and that of the intestine.

Robert T. Miller[27] reported a case of intestinal obstruction due to an enterogenous mesenteric cyst causing volvulus in a female child operated upon when four days old. On the mesenteric side of the jejunum, about 12 cm. from the pylorus, was a cystic tumour, measuring 4 cm. in its long axis and 3 cm. in its transverse axis. The cyst lay between the layers of the mesentery, intimately connected with the jejunal wall; for a distance of 4·5 cm. the bowel was greatly compressed by the subjacent mass, being flattened out into a ribbon-like band 1·5 cm. across at its widest point. The

cyst was lined by a single layer of columnar cells; over the greater portion of the cyst wall these were thrown up into well-developed villi. The villi were of their maximum size in the region most remote from the gut, gradually diminishing in height and number as the gut was approached; at the same time the epithelial cells diminished in height, becoming low columnar, then cuboidal, and finally over that portion subjacent to the lumen of the bowel the epithelium was quite flattened out. Below this layer was a submucosa, then two well-developed muscle layers, arranged at right angles to one another. As the bowel was approached, the inner muscle layer split into two portions and became continuous with the inner circular muscle layer of the jejunum. The external layer of muscle in the cyst wall remained intact and was directly continuous with the external longitudinal muscle of the bowel, thus forming a muscular envelope common to them both. We have here, then, an intermuscular enterogenous cyst, projecting between the layers of the mesentery.

Norman Moore[28] reported the following case: "The intestines of a man, age 40, showing three diverticula in the first three feet of the small intestine, and a congenital stricture at the commencement of the jejunum. The diverticula are each an inch long and about as much in diameter, and are on the mesenteric side of the intestine. Their walls consisted of all the intestinal coats and they were not mere hernial protrusions."

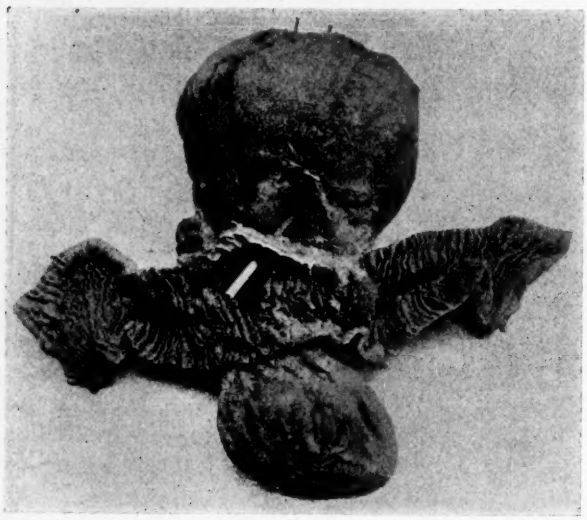

FIG. 38.—Bilocular developmental enterogenous cyst attached to the jejunum. (*From 'Deutsche Zeitschrift für Chirurgie'*, 1904, 109.)

Von Puschmann[29] found in the abdomen of a boy, age 6, who had died from general peritonitis, a cyst attached to the jejunum 25 cm. from the duodenojejunal flexure (*Fig.* 38). The cyst was situated on the mesenteric aspect of the gut. It was bilocular; the larger division is described as being as big as 'a man's fist', the smaller the size of 'an apple'! The larger division was situated in front of the mesentery, the smaller was post-mesenteric. The cyst was attached to the gut over an area the size of a '5 shilling coin'! A part of this attachment had been torn, with the result that there was a hole in the cyst and another in the adjacent portion of jejunum. Through this hole fæces had escaped into the general peritoneal cavity, resulting in the death of the patient. The structure of the cyst wall resembled that of gut, and the two layers of muscle were found to be continuous with the corresponding layers of the adjacent jejunum.

ILEUM.

Roth[17] reported a case of a diverticulum situated 66 cm. from the ileocæcal valve. It was attached to the mesenteric border of the ileum by a pedicle 11 mm. long, through which it communicated with the lumen of the gut (*Fig.* 39). The wall showed the structure of normal intestine. This case was presumably a Meckel's diverticulum.

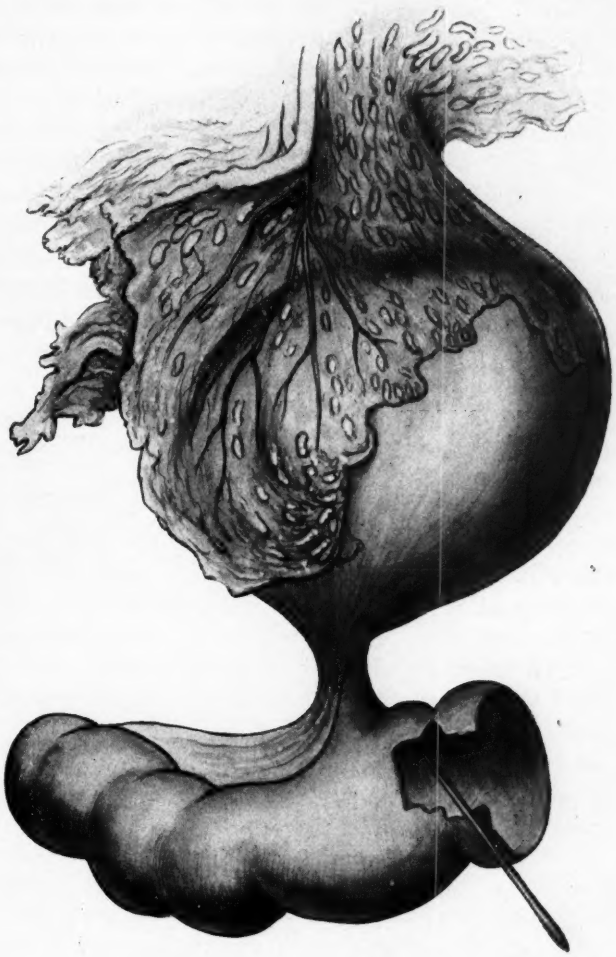

FIG. 39.—Diverticulum of the ileum. (*After 'Virchow's Archiv'*, lxxxvi, *Taf.* xv, *Fig.* 1.)

Tiedemann[30] found a similar cyst in a full-term fœtus. It was pear-shaped, pedunculate, and attached to the convexity of the intestine. It was 14½ lines long and 7 lines wide. Its cavity communicated with that of the intestine by means of a canal in the pedicle large enough to admit a probe.

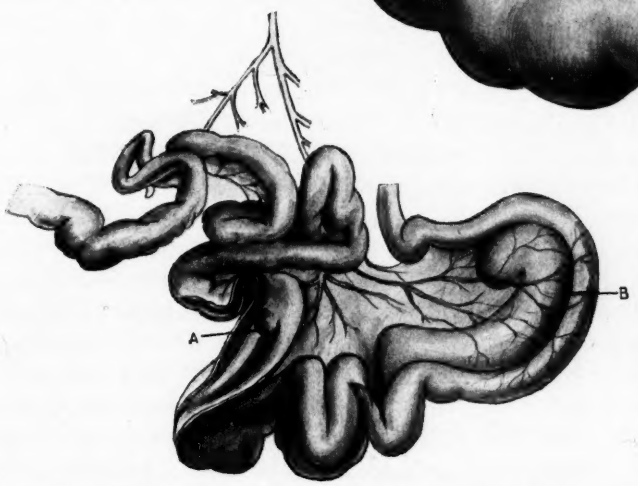

FIG. 40.—Developmental diverticulum of the ileum, situated between the layers of the mesentery. A, Mouth of diverticulum; B, Diverticulum. (*After 'Virchow's Archiv'*, lxxxvi, *Taf.* xv, *Fig.* 3.)

Roth[17] reported another case in which a cystic tumour 10 cm. long was situated between the layers of the mesentery of the ileum. The opening into the gut was situated 14·5 cm. above the ileocæcal valve (*Fig.* 40). Section of the tumour wall showed all the structures of the intestinal wall, with cylindrical epithelium, goblet

cells, villi, Lieberkühn's glands, Peyer's patches, a well-developed muscularis mucosæ, submucosa, two layers of muscular fibres, and peritoneum. This case is of interest, in that the cylindrical epithelium lining the cyst was ciliated. At the distal end of this intramesenteric diverticulum, a cyst was seen the size of a bean, also lying within the mesentery. The structure of the wall was similar to that of the intestine. The epithelial lining was composed of cylindrical cells, some with and some without cilia. In this subject were also found a gut-lined cyst connected with the œsophagus, and another connected with the 3rd portion of the duodenum (*see Fig.* 36).

Hilton Fagge[31] says: "One of the preparations in our Museum is a specimen of a diverticulum distinctly stated to have been situated above the middle of the ileum. This diverticulum is as large as a hen's egg, and has an unusually rounded form, but it appears to possess all the intestinal coats.

F. van der Bogert,[32] in a female child, age 5 years, found a large cyst about 18 cm. in its longest diameter, two somewhat smaller cysts (containing about 1·5 litres of fluid), and ten small cysts. "All the cysts had their origin in the mesentery of the ileum. There was no well-defined pedicle, the attachment being in the mesentery and extending along the intestine for a space of about 12 cm." "Under the microscope the outer surface was seen to be covered with normal peritoneum. The subserous tissue contained many congested blood-vessels. Beneath the connective tissue were found many smooth muscle fibres arranged in bundles and forming two distinct layers running at right angles to each other, the arrangement being characteristic of the structure of the intestines. No epithelial lining was detected."

Hennig[33] reported the case of an abdominal cyst the size of a moderately filled adult stomach. It occurred in a newborn child, and filled the anterior part of the abdomen. The sac measured $8\frac{1}{2} \times 5\frac{1}{2} \times 4$ in., lay within the mesentery, and did not communicate with the intestine. It held 100 grm. of clear, pale red, somewhat viscid, slimy fluid; its inner wall contained intestinal glands, and was covered with cylindrical epithelium.

Shallow[34] reported a case of entero-mesenteric cyst occurring in a child 5 months old, with a greatly distended abdomen, in whom a provisional diagnosis of Hirschsprung's disease was made. On opening the abdomen a cyst was found which was in direct contact with the small intestine, and extended from four inches from the ileocæcal valve for a length of 40 cm.; 1500 c.c. of clear amber-coloured fluid were evacuated from the cyst, and the cyst with the adjacent portion of small intestine was removed. There was no communication between the cyst and the lumen of the gut. Section of the wall showed three coats of non-striated muscle, an outer longitudinal, a middle circular, and an inner longitudinal. It was lined in parts by columnar epithelium. The epithelial lining was not constant, but in places the columnar cells were several layers thick, and some of the cells 'appeared to be ciliated'.

Strode and Fennel[35] report a case in a child operated upon when four days old for intestinal obstruction. A tumour was found in the lower ileum, in size about 1·5 × 1 cm., causing the anterior surface of the ileum to protrude, about 6 cm. proximal to the ileocæcal junction. The gut distal to the cyst was collapsed, and distended above it. An incision was made into the wall of the ileum and the cyst was shelled out. It was then found that

another cyst completely occluded the lumen of the intestine, dilating it to a diameter of about 3 cm. This portion of gut was excised. The small cyst was "lined by papillomatous and flattened squamous epithelium, and had a muscular wall continuous with the musculature of the intestine." We have, in this interesting case, two cysts of intestinal origin, one intermuscular and the other within the lumen of the gut (analogous to those cysts which, moving centrifugally, ultimately become intramesenteric).

Eve[36] described two mesenteric cysts. One occurred in a child, age 11 weeks, in whom an abdominal tumour could be felt (the size of a small kidney). It could be freely moved all over the abdominal cavity. The swelling could be felt per rectum. A cyst the size of a tangerine orange was found between the layers of the mesentery of the small intestine (*Fig.* 41). Two ounces of fluid were aspirated from the cyst, the aperture was closed, and the cyst sutured into the wound. A week later the cyst was incised, washed

FIG. 41.—Mesenteric cyst. A shows the cyst and its attachment by operation to the abdominal wall; B shows the diminution in size of the lumen of the ileum produced by the cyst. ('*Med.-Chir. Trans.*' 1897–8. Specimen No. 1220.1, *R.C.S. Museum.*)

out, and a drainage tube inserted. A month later the child died following convulsions. When microscoped, no endothelial or epithelial lining was found, but just beneath the surface a thin layer of unstriped muscle cut longitudinally was seen, then a thick layer of muscle divided transversely, followed by another thick layer composed of several fasciculi running parallel to the surface. From this structure it can safely be assumed that we have here a developmental enterogenous cyst.

Since writing the above I have been examining Eve's specimen in the Royal College of Surgeons Museum, and was shown a microscopical section of the wall of this cyst which was made by Mr. Shattock when the specimens were being re-arranged. From an examination of this section (*Fig.* 42) it will be seen that my assumption that this was a developmental enterogenous cyst is justified; for although my diagnosis was founded on the original description of the muscular layers in the wall of the cyst, Mr. Shattock's section reveals a mucosal lining having intestinal characters, and places the cyst without any doubt in the category of enterogenous cysts. The case is thus described by Mr. Shattock: "The wall of the cyst is comparatively

thick, and, beneath its lining membrane, consists of a well-developed layer of tawny muscle fibre. Microscopic sections show that the wall is furnished with a double layer of unstriped muscle fibre, and in certain spots with a mucosa having intestinal characters, i.e., provided with crypts embedded in lymphatic tissue. Beyond the areas referred to, the mucosa becomes thinner and thinner, the crypts being much more and more oblique, as if from pressure, till the proper structure ceases to be recognizable. The calibre of the bowel is considerably reduced by the pressure of the swelling. The cyst is probably a fœtal diverticulum of the intestine of which the original communication has become closed."

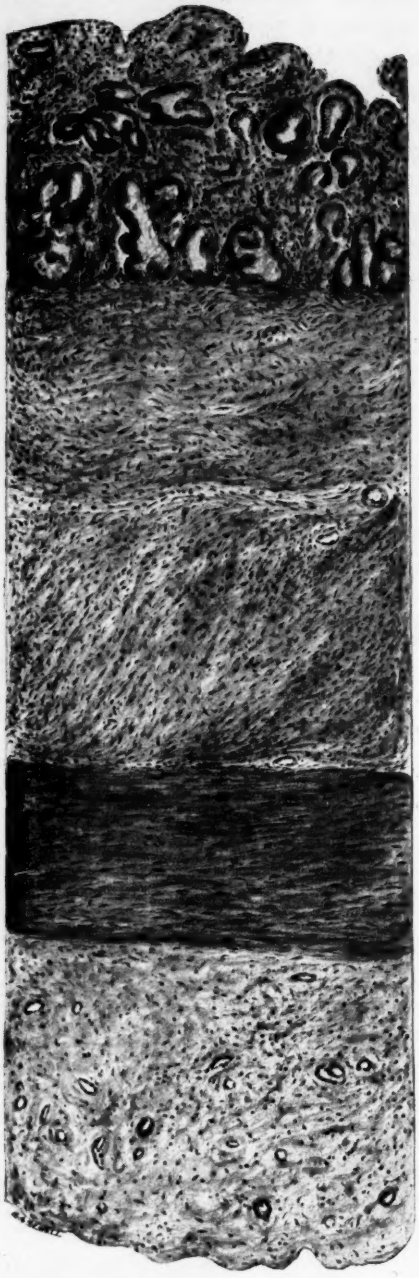

FIG. 42.—Microscopical section of Eve's mesenteric cyst, showing a mucosal lining and two layers of unstriped muscle fibres.

Wallman[37] reports the following specimen in the Joseph's Akademie, Vienna. One piece of small intestine, 48 cm. long, contained thirty-seven diverticula varying in size from a pigeon's egg to that of a bean. Of these, thirty lay between the layers of the mesentery. Many of them were in the closest possible apposition to one another.

Studsgaard[38] described a cyst which he found in the mesentery of a girl 14 years old. The abdomen had been distended for years, and had been tapped on two occasions, three and ten years previously. The anterior layer of the mesentery over the tumour was incised, the cyst wall was punctured, and 2000 c.c. of chocolate-coloured fluid withdrawn. The cyst was enucleated, difficulty being experienced in the region of the pedicle, which was a funnel-shaped prolongation of the cyst towards the spine. This was ligatured, cut across, and the stump cauterized. "The cyst wall was in perfect agreement with the wall of the intestine."

Terrier and Lecène[39] reported an example, found post mortem, which was situated in the mesentery of the small intestine, 50 cm. above the ileocæcal valve. Its walls contained muscular fibres, and it was lined by columnar epithelium. These authors in their

valuable communication suggest for the type of cyst we are considering, and which on section shows the structure of the intestinal wall, the name 'enteroides'.

Gfeller[40] operated on a female child, 11 years of age, for intestinal obstruction. He found one coil of small intestine had undergone rotation

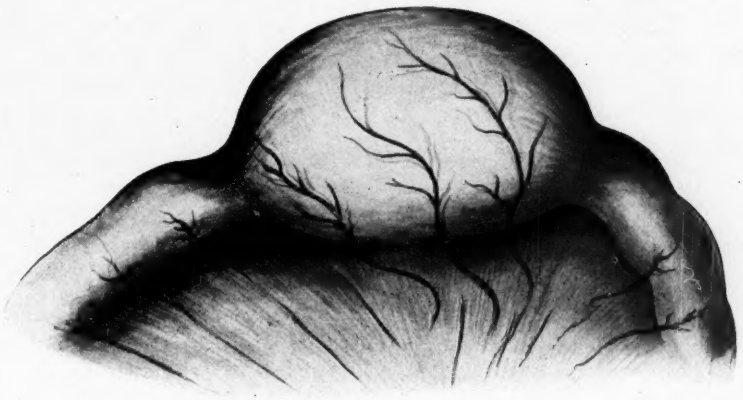

FIG. 43.—Enterogenous cyst situated in the ileum, producing volvulus and intestinal obstruction. (*After Gfeller, 'Deutsche Zeitschrift für Chirurgie'*, 1902, 330.)

through 360°. On following the dilated portion a tumour the size of an orange was found in the pelvis. It was situated on the antimesenteric border of the bowel, and seemed part of it (*Fig.* 43). On delivering the

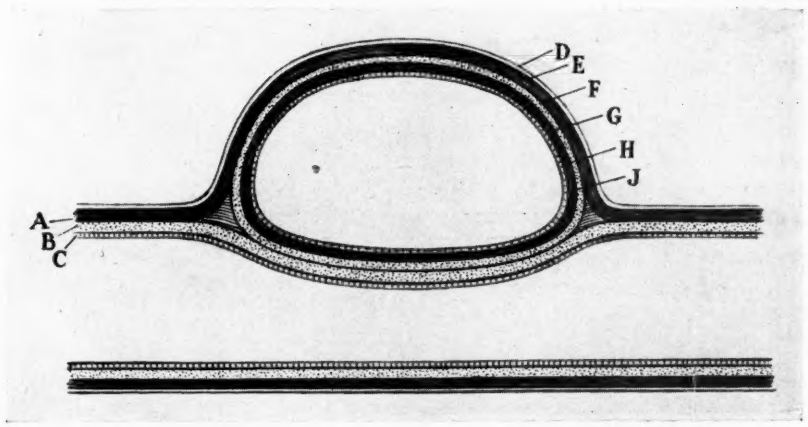

FIG. 44.—Longitudinal section through the tumour and intestine shown in *Fig.* 43. The enterogenous cyst is seen to be intermuscular. A, Long muscle; B, Circular muscle; C, Mucosa; D, E, F, G, Serous, subserous, longitudinal, and oblique muscular fibres; H, Muscular fibres, partly oblique and partly longitudinal; J, Mucosa. (*After Gfeller, 'Deutsche Zeitschrift für Chirurgie'*, 1902, 330.)

intestine the volvulus was easily untwisted and the contents of the dilated part passed easily along the lumen of the bowel into the distal contracted loops. The tumour was 7·8 cm. long, cystic, unilocular, covered with peritoneum and with the longitudinal muscle of the bowel (*Fig.* 44). These

were divided and the tumour easily shelled out by peeling the longitudinal muscle from it, and by separating it from the circular muscle fibres. It had no connection with the lumen of the intestine. The wall of the cyst was composed of three layers of unstriped muscle; the epithelial lining consisted in greater part of stratified epithelium, with occasional groups of cylindrical and of cuboidal cells.

Frankel's[41] case was found in a female child who died at the age of 3 days from intestinal obstruction. There was a globular swelling 2·5 cm. in diameter at the end of the ileum, between the muscular coats of the gut. Histological sections were not made till thirty years afterwards; the walls of the cyst were found to contain muscular fibres, but there was no discoverable mucosa. It would be difficult to describe a case more graphically and in fewer words than those in which Gfeller summarizes this one: "Intestinal obstruction; fæcal vomiting; energetically purged; death."

Seligmann's[42] case was 6 cm. from the ileocæcal valve. The structure of the cyst wall was similar to that of the intestine, and the cyst was situated in the muscularis mucosæ.

Dittrich[43] reported one case 30 cm., and another 60 cm., from the ileocæcal valve. In the first case the histological section was similar to that of small intestine, including Lieberkühn's glands. In the second the cyst wall presented the structure of small intestine, but was thinner; the outer muscular layer was directly continuous with that of the gut.

Kulenkampff[44] records a case in a patient, 3 years old, who died of intestinal obstruction from torsion of the small intestine. There was seated in the mesentery, 40 cm. from the ileocæcal valve, a cystic tumour the size of a man's fist. There was no communication with the bowel. Kulenkampff states that the case was of the same nature as Roth's.

Nasse[45] reports a cyst in the small intestine the size of an egg, 80 cm. from the cæcum. It projected into the mesentery and into the lumen of the gut, which was completely interrupted, ending blindly proximally and distally to the cyst. The cyst was lined with tall columnar epithelium; there were several goblet cells.

Tiedmann's[46] case (1813), referred to by Roth, was a pear-shaped cyst situated at the umbilicus and attached by a long pedicle to the convex border of the intestine. There can be little doubt that this was a Meckel's diverticulum.

Quesnel[47] reported four cases. The first was found in a newborn child. This was a cyst 3 cm. long in the submucosa on the antimesenteric wall of the ileum, near the cæcum. There was no communication with the gut lumen. Section showed two layers of muscle, and an atrophied mucosa with here and there columnar epithelium and glands. In his second case, a female child 4 months old who died of pneumonia, there was a similar cyst of the same size, near the cæcum, not communicating with the gut lumen. The wall showed on section a mucosa with columnar and goblet cells, glands, and two layers of muscle. His third case occurred in a female, age 62, who was operated upon for intestinal obstruction. The cyst was situated between the two muscular coats of the ileum in the antimesenteric wall, 57 cm. above the ileocæcal valve. It was composed of two parts, a smaller portion towards

the bowel lumen, and a larger cystic portion away from the lumen. The solid portion showed the structure of a spindle-celled sarcoma. Quesnel's fourth case is peculiarly interesting in that the mucosa of both cyst and adjoining intestine was tuberculous. The cyst, which showed the structure of the small intestine, was quite shut off from the lumen of the gut.

Hedinger,[48] in a post-mortem on a boy 5 years old, found a cystic tumour extending from symphysis to umbilicus and from one iliac crest to the other. It contained a litre of milky fluid. It was attached to the mesentery of the ileum 4 cm. from the root of the mesentery, 10 cm. from the ileocæcal valve. There was no communication with the intestinal canal. Section showed a peritoneal coat, two muscular layers, a muscularis mucosæ, and an epithelial lining; this lining in some places showed cylindrical epithelium, in most places flattened epithelium, and in some situations was devoid of any epithelial element. There can be no doubt that this cyst properly belongs to the group of developmental enterogenous cysts.

ILEOCÆCAL REGION.

Many cysts of intestinal structure have been discovered in this region and have been described as 'ileocæcal cysts'. They may occur in any part of the cæcum, at the ileocæcal junction, or in the adjacent ileum. They may project into the lumen of the gut, being sessile or pedunculated. They may be situated beneath the peritoneum, on the mesenteric or on the anti-

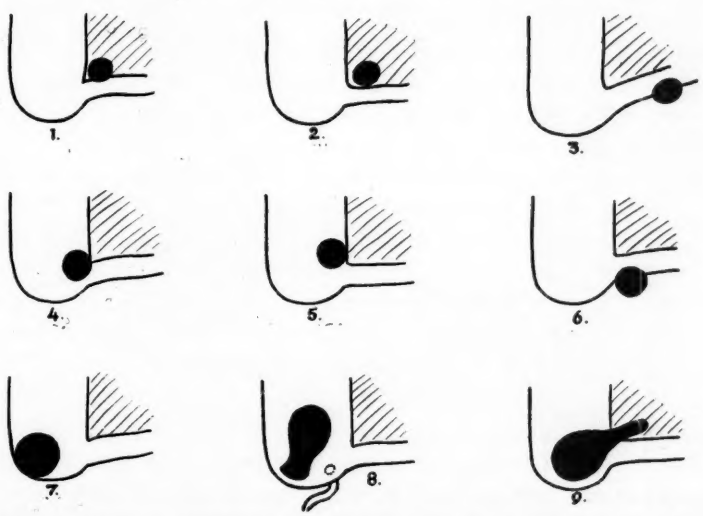

FIG. 45. — Position of developmental enterogenous cysts occurring in the ileocæcal region; the so-called 'ileocæcal cysts'. 1, Bolton and Lawrence; 2, Sir Arthur Keith, Turner and Tipping; 3, Neupert; 4, MacAuley, Hueter; 5, Sainsbury, Bazin; 6, Quesnel; 7, Blackadder, Girling Ball, Edwards; 8, Evans; 9, Ayer.

mesenteric border of the gut. They may be situated within the mesentery, unattached to the gut. These cysts differ in no respect from those we have described as occurring in the duodenum, jejunum, or ileum; they are developmental enterogenous cysts. The different positions in which they have been found are indicated in *Fig.* 45.

Sainsbury[49] described a cyst which he found post mortem in the first part of the ascending colon. The ileocæcal valve was situated below and somewhat behind the base of the attachment of the tumour (*Fig.* 45 5). The cyst was about the size of a duck's egg. Externally it was covered by a mucous membrane similar to that which lined the large intestine. The inner layer presented the structure of a serous membrane. In places a distinct muscular coat was present. From its position and the muscular fibres in its wall, I consider that this is a case of developmental enterogenous cyst.

Ayer[50] found the lumen of the cæcum occupied by a cyst as large as a duck's egg. It was sessile over about one-fifth of its surface, that portion being attached to the mesocolic border. At the site of attachment there was a funnel-shaped pocket extending for about two inches between the layers of the mesentery of the ileum, and just large enough to admit easily the examining finger. No microscopical examination was made of the cyst wall, but I have no doubt this was a congenital intestinal cyst projecting both into the lumen of the gut and between the layers of the mesentery (*Fig.* 45 9).

Fehleissen[51] reported a multilocular cyst containing 8200 c.c. of clear reddish fluid. There were three layers in the wall: an outer of dense connective tissue; a middle of very vascular connective tissue, loosely arranged; and an inner of unstriped muscle fibres arranged longitudinally, but with large bundles having a more or less irregular distribution. Fehleissen says, "the muscle fibres were characteristic; they differed in no respect from those found in the intestinal tract or in the bladder wall." (*See also* Conant[52], Baldwin[53], and Bolton and Lawrence[54].)

Hueter's[55] case is interesting in that it was situated under the mucosa at the ileocæcal valve (*Fig.* 45 4). It was the size of a cherry-stone. It was lined with cylindrical cells and goblet cells, outside of which was a layer of lymphoid cells (*Fig.* 46).

Sprengel's[56] case occurred in a female, 15 years old, on whom a laparotomy was performed for suspected tuberculous peritonitis. The cæcum was resected for a tumour in that region. A cyst 3 cm. long was found on the 'left side' of the ileocæcal valve, subserous. It had no communication with the lumen of the gut. Microscopical examination showed columnar epithelium, tubular glands, lymphoid tissue, and a few muscular fibres.

Blackadder[57] reported a cyst of the cæcum in an infant 10 weeks old (*Fig.* 45 7). Microscopical examination showed the surface of the tumour projecting into the lumen of the cæcum covered with mucous membrane similar to that of the intestine; the cyst was lined with a somewhat stretched layer of columnar epithelium, which, however, in some places was folded into gland formation. Beneath each surface of epithelium was a submucosa infiltrated with leucocytes, and between these again were three more or less distinct layers of muscle.

Neupert[58] reported the case of a boy 10 years of age admitted into hospital with a painful circumscribed swelling in the ileocæcal region. On opening the abdomen a tumour about the size of a hen's egg was found in the ileum 10 cm. from the ileocæcal valve. The tumour occupied the antimesenteric side of the bowel (*Fig.* 45 3). Microscopical sections of the wall showed a lining of cubical epithelium with traces of a submucosa.

Externally and internally the cyst was enclosed by the muscular layer of the intestinal wall.

Turner and Tipping[59] reported the following case: A tense cyst about one inch in diameter was found in the mesentery, in the angle between the ileum and the colon (*Fig.* 45 2). It bulged into both these portions of intestine, causing obstruction at the ileocæcal valve. An attempt was made to remove the cyst, but although it was easily separated from the mesentery

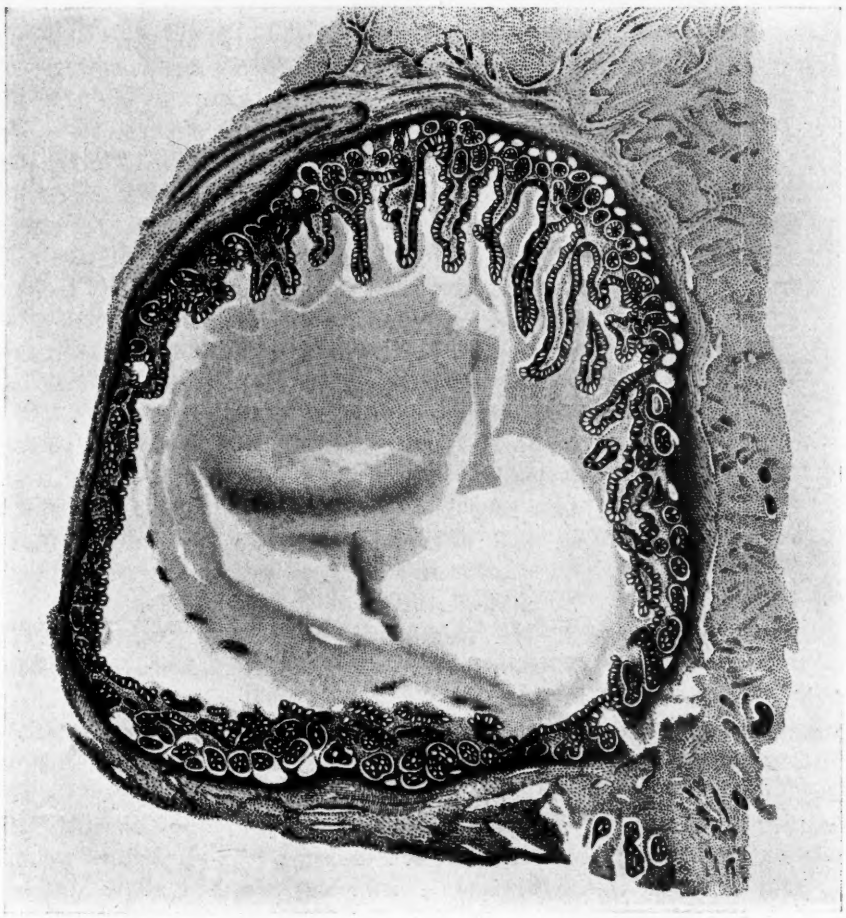

FIG. 46.—Developmental enterogenous cyst situated under the mucosa of the ileum, near the ileocæcal valve. (*From* '*Zeigler's Beiträge*', 1896, xix, 391.)

its walls appeared to be absolutely incorporated with the wall of the ileum and the cæcum. As it seemed that a further attempt at removal would result in damage to the bowel, the cyst was incised and a quantity of white, odourless, glairy fluid was evacuated. There was no communication between the cavity of the cyst and the bowel. The greater part of the cyst wall was cut away and the edges were sewn to the parietal peritoneum. Mucoid material discharged from the wound for some time, but this eventually healed. Since

then on two occasions incisions have been required to allow of the escape of mucoid material which has collected in the cavity. A section of the cyst wall showed a structure closely resembling small intestine.

MacAuley[60] reported a case of a baby girl, age 6 months, operated upon for intussusception. The intussusception having been reduced, a tumour could be palpated in the cæcum at the site of the ileocæcal valve (*Fig.* 45 4). The ileocæcal region was resected, and is now in the Museum of the Royal College of Surgeons (Specimen 548.63).

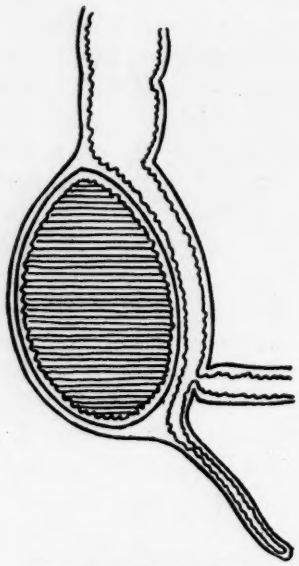

FIG. 47.—Developmental enterogenous cyst in the cæcum. (*After Lotheissen, 'Deutsche Zeitschrift für Chirurgie'*, 1925, 179.)

Girling Ball[61] reported a case very similar to mine (*Fig.* 45 7).

Lotheissen[62] found in a female, age 21, a large cystic swelling in the interior of the cæcum (*Fig.* 47.) He attempted to enucleate the cyst by incising down the tænia, but failing, he resected the ileocæcal region and performed a lateral anastomosis with the transverse colon. This case is almost identical with my own (*Fig.* 45 8).

Bazin[63] reported a case of mucous cyst of the cæcum. After reduction of an ileocæcal intussusception, a hard mass still persisted, situated on the inside of the medial wall of the cæcum just above the ileocæcal valve (*Fig.* 45 5). "Microscopical examination of the cyst wall showed its outer layers consisted of mucosa, submucosa, and two muscle layers, all comparable to that found in the adjoining cæcum; its inner layers were composed of a fragmentary layer of muscle lined by a single layer of cuboidal cells."

In the Royal College of Surgeons Museum, Specimen No. 1221.1 is "a spherical retroperitoneal cyst 4 in. in diameter, intimately connected with the lower end of the ascending colon. Histologically the wall of the cyst consists of fibrous tissue with intermingled unstriped muscle fibres, lined with well-developed mucus-secreting epithelium; here and there the surface raised into low papillæ."

Another specimen in the Royal College of Surgeons Museum (No. E. 16. A) is a cyst removed by Mr. Harold Edwards.[64] The patient was a girl, age 12, who suffered from symptoms resembling those of acute appendicitis. On opening the abdomen a mass was discovered in the right wall of the cæcum just below the level of the ileocæcal valve (*Fig.* 45 7). The mass proved to be a cyst in the cæcal wall. The cyst measured $3\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{3}{8}$ in. The wall contained a narrow band of circular muscle fibres and a submucous layer, and was lined by a single layer of low columnar epithelium.

VITELLO-INTESTINAL TRACT.

At the beginning of the fourth week of intra-uterine life the midgut is in wide communication with the yolk-sac. By the end of the fourth week the midgut has become tubular, and its communication with the yolk-sac has become tubular, forming the vitello-intestinal duct. Coursing over this duct

and the yolk-sac is the artery of the yolk-sac—the continuation of the superior mesenteric artery. In the sixth week the vitello-intestinal duct and the vessels accompanying it atrophy. The yolk-sac, by the constriction of the umbilical orifice and formation of the cord, comes to lie on the placenta, where a remnant of it may be found at birth near the implantation of the cord.

Meckel,[65] describing the anomalies of the abdominal portion of the alimentary canal, says: "The special deviations of primitive formation in the intestinal canal are:—

"*a*. The prolapsus of this canal into the umbilical sheath in a case of exomphalos. Instances of this anomaly are most frequent in the small intestine, as, when the development is normal, this portion of the canal enters last into the abdomen.

"*b*. The more or less perfect continuance of its primitive connection with the umbilical vesicle. This anomaly exists in several different degrees. Sometimes the umbilical vesicle continues beyond the usual time, and communicates with the ileon by an open canal which the omphalo-mesenteric vessels attend. Sometimes only a canal exists; it varies in length, and extends from the same point of the ileon to the umbilicus, where it opens, and the omphalo-mesenteric vessels also accompany it.

"*c*. Finally, sometimes a greater or less prominence exists in this place, a prolongation termed the *diverticulum of the ileon*. This is often accompanied by the omphalo-mesenteric vessels, which float loosely at its extremity, which are attached to the umbilicus or to another region of the intestinal canal, so as to form a plexus." ("Quite recently I found them in a child of three months, arising, as usual, from the superior mesenteric artery and vein, running along the entire length of the diverticulum, and converted at its end into a solid thread, several inches long and hanging free."[66])

"These three anomalies are only different degrees of the same deviation of formation. This is proved by their appearing always in the same place, by their connections with the omphalo-mesenteric vessels, and, finally, by the fact that they always have the character of a primitive formation. That they depend on a primitive formation is proved by the facts that they are always observed in the same place, that they are formed by all the membranes of the intestinal canal, and that they exist simultaneously with other primitive deviations of formation, which arise from the development being arrested, or which, at least, favour their productions. All these circumstances united demonstrate that it is impossible to regard them purely as accidental productions, excrescences, contractions or hernias of the ileon."

Meckel notes the fact that in addition to diverticula whose existence was due to persistence of the vitello-intestinal tract (and which he called 'true' diverticula) there were others whose existence could not be so explained—these he called 'false' diverticula. "The false diverticulum differs from the true diverticulum [i.e., Meckel's diverticulum] by its rounded form, by the absence of several superimposed tunics, and, finally, by its occurring in every part, even in the stomach, but most frequently in the duodenum, and by the existence of several at once." Meckel considered that these were dependent upon solutions of continuity in the gut wall, resulting either from mechanical influence as the action of a cutting instrument, a rupture, or from a previous

alteration of texture as from ulcerations. "These solutions of continuity are sometimes complete, and then affect all the tunics; sometimes confined only to the muscular and peritoneal membranes, whence results a hernia of the inner membrane, and the formation of a rounded tumour termed a false diverticulum (div. spurium)."

Meckel, then, recognized two classes of diverticula: (1) Those derived from the vitello-intestinal tract; (2) Those not derived from the vitello-intestinal tract, which he called 'false'. By 'false' he undoubtedly meant any diverticulum not derived from the vitello-intestinal tract; and he considered all these were dependent on 'solutions of continuity'—either traumatic or from alterations in structure, e.g., inflammations—and that in all of them there was an 'absence of several superimposed layers'. We now know that some of these diverticula in stomach, duodenum, and elsewhere are not dependent upon trauma or any inflammatory process, and have no 'solution of continuity' in their coats; they are developmental in origin. But, as Meckel's 'true' diverticula were those, and those only, which were derived from the vitello-intestinal tract, it followed that these developmental enterogenous diverticula were grouped together with those which were obviously 'acquired', and to which alone the term 'false' or 'spurious' might fitly be applied. Because of this imperfect grouping one has repeatedly noted confusion in the description of cases recorded since Meckel's time. Thus, a diverticulum whose walls faithfully repeated the structure of normal gut has been assumed *ipso facto* to have originated in the vitello-intestinal tract, irrespective of the portion of gut from which that diverticulum arose (including even diverticula of the œsophagus); and a diverticulum not originating in the vitello-intestinal tract has been assumed to be 'false', and therefore 'acquired'. Conclusive proof that the vitello-intestinal tract is not the only possible source of a developmental intestinal diverticulum is afforded by those cases in which more than one such diverticulum has been found.

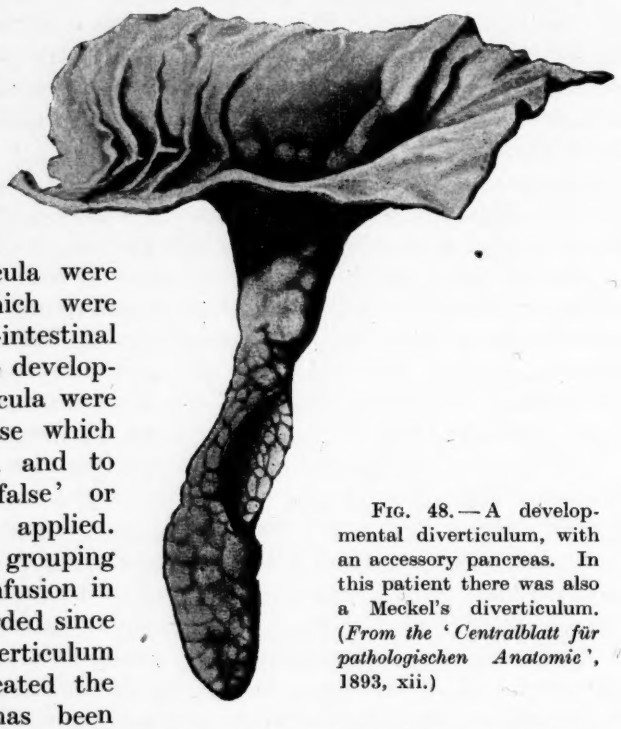

FIG. 48.—A developmental diverticulum, with an accessory pancreas. In this patient there was also a Meckel's diverticulum. (*From the 'Centralblatt für pathologischen Anatomie'*, 1893, xii.)

Nauwerck[67] reported the occurrence, in a man, 43 years old, of a diverticulum 2·3 in. above the ileocæcal valve. This was of the thickness of a lead pencil and 9 cm. long; it arose from the free border of the gut. Attached to its tip there was found an accessory pancreas (*Fig.* 48). This, said Nauwerck, so closely resembled the case described by Zenker that he would have

considered it to be a Meckel's diverticulum with an accessory pancreas—had it not been for the fact that 80 cm. above the ileocæcal valve he found a typical Meckel's diverticulum 3 cm. long. Zenker's[68] case, to which Nauwerck referred, was that of a Meckel's diverticulum 54 cm. above the ileocæcal valve. This was 5½ cm. long. It possessed a small fat mesentery. In this mesentery near the tip of the appendix was an accessory pancreas the size of a cherry.

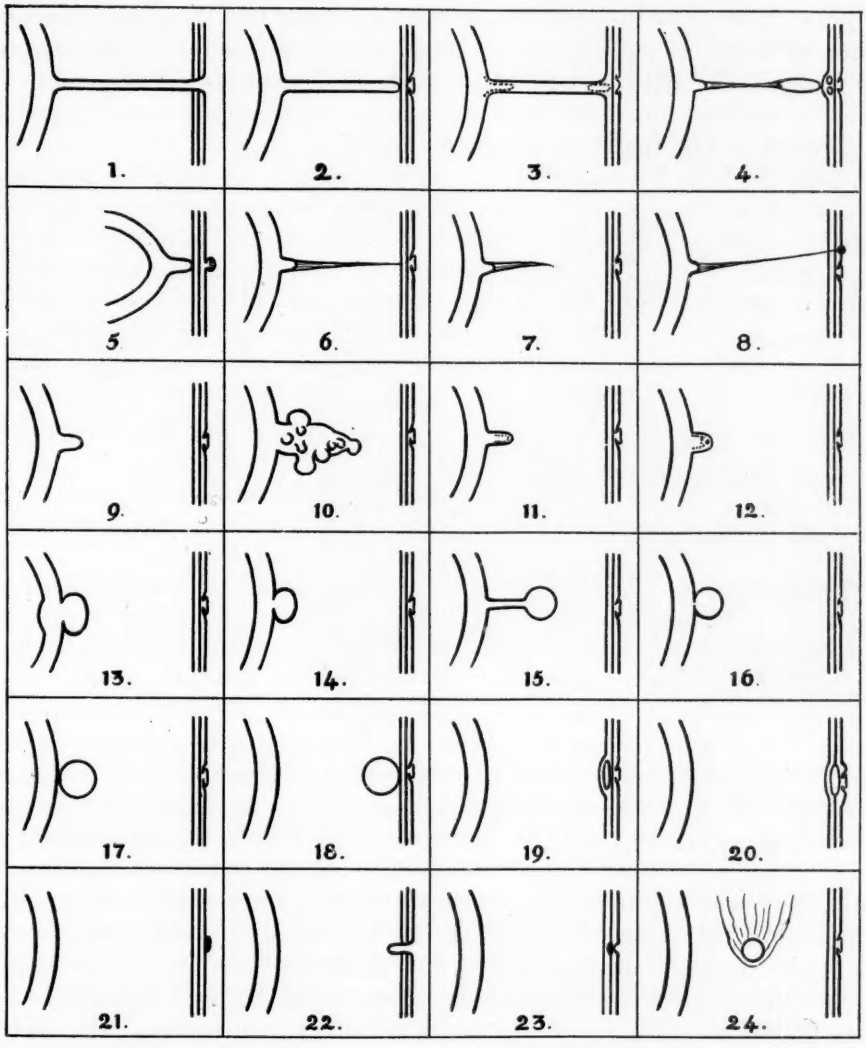

FIG. 49.—Anomalies dependent upon incomplete obliteration of the vitello-intestinal tract. The numbers correspond to those of the 24 cases cited in the text.

Roth[17] reported a case in which there was a cyst lined by gut epithelium in the thorax and another connected with the third portion of the duodenum; also a diverticulum of the ileum lying between the layers of the mesentery, and at its extremity a gut-lined cyst (*see Fig.* 36). In this case there must have been three diverticula from the primitive intestinal tract.

The proper classification of intestinal diverticula is: (1) Developmental: (*a*) Those consequent on failure in the obliteration of the vitello-intestinal tract (Meckel's diverticula); (*b*) Those consequent on the persistence of the diverticula which normally occur in the fœtal entoderm. (2) Acquired.

Although the anomaly most commonly associated with imperfect obliteration of the vitello-intestinal tract is the persistence of its intestinal attachment (i.e., Meckel's diverticulum), it should be noted that *any* portion of this tract may persist, either within the abdominal cavity, or in its passage through the abdominal wall. It should also be noted that any portion of this tract may show heterotopic differentiation. *Fig.* 49 indicates these various developmental anomalies, and illustrative cases follow, the numbers corresponding to the numbers of the diagrams in the figure.

1. F. W. King[69] reports a case in a boy, age 14 months. Ever since the funis came off, on the 11th day after birth, he is stated to have had a discharge from the umbilicus of a thin yellow colour, and of a faint odour. There was no doubt that the sinus communicated with the small intestines. This was later proved at a post-mortem examination. The diverticulum, about 3 in. long, was found adhering to the umbilicus, and an adventitious cord appears to have compressed the ileum just below its connection with the diverticulum.

2. Hilton Fagge[70] quotes a post-mortem by Dr. Wilks on a girl of 10 who died of peritonitis. A Meckel's diverticulum was found about 15 in. above the cæcum. This was attached to the abdominal wall in the region of the umbilicus. It was pervious as far as the umbilicus, where it terminated in a blind end. It would admit an ordinary lead pencil.

3. Barron[71] at an autopsy found a narrow Meckel's diverticulum possessing a thick cord-like attachment to the abdominal wall in the region of the umbilicus. The umbilicus itself appeared normal. The proximal cavity was lined by mucosa exactly resembling that of the small intestine. In the apparently solid portion of the cord-like prolongation was a small cavity, 2·5 cm. by 2 mm., separated from the proximal diverticulum by a thin connective-tissue septum. This narrow cyst was lined by gastric mucosa.

4. Wilkie[72] operated on a boy, age 15, for acute intestinal obstruction. He found, about a foot from the ileocæcal valve, a tense sausage-shaped cystic swelling; this was attached by a broad and twisted pedicle to the ileum, and its other end was moored to the abdominal wall at the level of the umbilicus. At the point of attachment to the ileum it had, by its torsion, caused an acute kink, with complete obstruction of the intestinal lumen. On excising the cyst, two other sessile cysts could be felt in the abdominal wall in the region of the umbilicus. "They evidently represented remnants of the omphalo-mesenteric duct in the abdominal wall, which had developed into separate cysts."

5. Cullen[73] reported a case of an umbilical polyp associated with a Meckel's diverticulum (*Fig.* 50). As Cullen says, "this case came within an ace of being one of patent omphalo-mesenteric duct."

6. Falk[74] found in a man, 20 years of age, a diverticulum 4½ in. long, two feet above the ileocæcal valve; a solid pseudomembranous ligament 1½ in. long ran from its apex to the abdominal wall an inch from the umbilicus. A

band which united the diverticulum and the mesentery had given rise to intestinal obstruction.

7. Meckel's[66] case, to which reference has already been made. The vitelline vessels form a cord hanging free.

8. Taylor[75] reports a case of Meckel's diverticulum 4 in. long, from the apex of which a fibrous band passed to the abdominal wall behind the umbilicus. In the superficial tissues of the umbilicus was a small hard reddish nodule the size of a pea, visible and palpable on the suface. Microscopically, the apex of the diverticulum was seen to be lined by mucous membrane identical with that of the gastric fundus. The umbilical nodule, covered by normal squamous

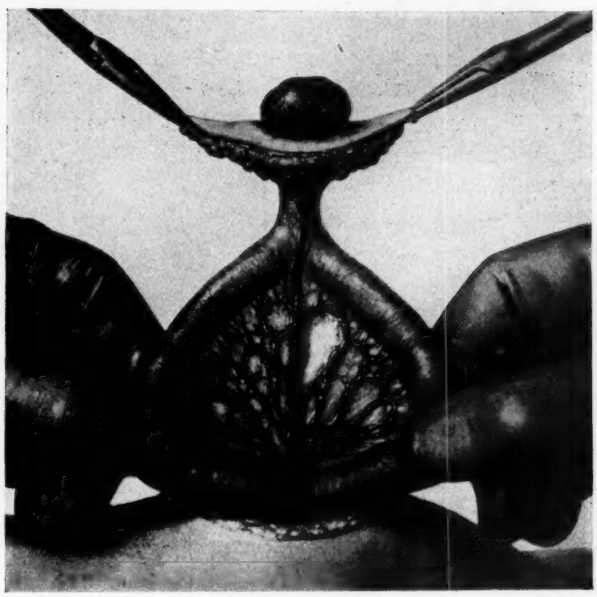

FIG. 50. — An elliptical incision including the umbilical polyp has been made and the umbilicus lifted well away from the abdominal wall. Passing off from the loop of small bowel is a Meckel's diverticulum. This is firmly fixed to the inner surface of the umbilicus. Firmly attached to the outer surface of the umbilicus is the umbilical polyp. A small hole on the surface of the polyp, into which a probe can be passed for 8 mm., is the remnant of the lumen which formerly was continuous with Meckel's diverticulum. The omphalo-mesenteric artery and vein still persist. The polypus is covered by mucosa typical of the small intestine. (*From 'Surgery, Gynecology and Obstetrics'*, 1922, xxxv.)

epithelium, was composed of fibrous tissue in which no heterotopic tissue was seen. It was continuous with the fibrous band running to the apex of the diverticulum.

9. This represents the classical Meckel's diverticulum.

10. A Meckel's diverticulum may possess one or more nodular projections; this one, removed by Mr. Rock Carling, has nine such accessory diverticula. (Westminster Hospital Museum, No. 525C.)

11. Taylor[75] reported 5 cases of Meckel's diverticulum at the apex of each of which the mucosa faithfully reproduced the structure of gastric mucosa.

12. In three of the cases of Taylor just mentioned, the superficial heterotopia were associated with deep heterotopia in the shape of aberrant pancreatic tissue.

13. A loop of ileum with an enormous Meckel's diverticulum (*Fig.* 51). The sac held 845 c.c.; it is sessile on the gut, with which it communicates by a very wide opening. (R.C.S. Museum, No. 548.W.)

14. A large ovoidal Meckel's diverticulum, 4 in. in its chief diameter. Removed by Sir Charters Symonds. (R.C.S. Museum, No. 548X.)

15. Meckel's diverticulum in the form of a large pedunculated cystic swelling. (*See* Roth's case, p. 55 and *Fig.* 39.)

16. Struthers[76] reported a case of death from peritonitis due to leakage from a rounded swelling which was attached by a broad base to the upper

FIG. 51.—Persistence of wide communication between the mid-gut and the vitello-intestinal tract. (*R.C.S. Museum*, No. 548.W.)

aspect of the mesentery two feet above the ileocæcal valve, and lying up against the small intestine. Section showed this to be a thick-walled cyst which communicated with the lumen of the adjacent gut by a minute canal (*Fig.* 52). The interior of the cyst and of the canal were lined by columnar epithelium; and the walls were composed of two layers of muscle fibres, longitudinal and circular.

FIG. 52.—Meckel's diverticulum forming a thick-walled cyst, communicating with the gut by a minute canal. (*From the 'Edinburgh Medical Journal'*, vii, No. 4.)

17. Meckel's diverticulum forming a cyst, sessile on the gut, but having no communication with it. (*See* Räsfeld's case, p. 73 and *Fig.* 56.)

18. Schaad[77] found in the abdomen of a woman, age 33, a cystic tumour attached to the abdominal wall two finger-breadths below the umbilicus. It communicated with a smaller cyst. In the cyst was a chocolate-coloured fluid containing cholesterol. The cyst was lined with normal intestinal mucosa.

19. Wyss[78] reported a cyst of the abdominal wall, $\frac{3}{4}$ in. above the umbilicus. It was the size of a bean, and lay between the muscle and the

peritoneum. The cyst contained a turbid mucoid fluid. In this fluid was a great number of cylindrical ciliated epithelial cells. The wall consisted of connective tissue with numerous fine elastic fibres. The inner lining was a continuous layer of ciliated epithelium.

20. Colmers[79] reports a case occurring in a woman, age 46, in whom he found a cyst the size of a small hen's egg attached to the parietal peritoneum, near the umbilicus. This cyst lay between the parietal peritoneum and the sheath of the rectus muscle, to which it was firmly adherent by a broad base. Below this, but not attached to it, was a smaller tumour the size of a hazel-nut; this, too, was adherent to the abdominal wall. It terminated in a short firm cord-like band which opened into the umbilicus. This band on section showed the structure of the remains of the omphalo-mesenteric vessels (*Fig.* 53), in which will be observed two patent vessels, containing blood and each surrounded by unstriped muscle fibres. The walls of the cysts are composed mainly of connective tissue, in which there is marked calcareous degeneration. No epithelial lining could be demonstrated inside the larger or the smaller cyst, but the inner lining of the larger cyst consisted of a narrow layer of necrotic tissue. At the base of the larger cyst and communicating with it by fine openings were two prolongations. These are lined by very tall cylindrical epithelium very like Lieberkühn's glands; here and there villi project into the lumen (*Fig.* 54). This layer rests on a muscularis mucosæ; then follow unstriped muscle fibres, which, although not arranged into two layers as regularly as that found in the gut wall, yet can readily be differentiated into circular and longitudinal fibres.

21. Stone[80] collected 38 cases of umbilical polypus, 34 of which were composed of normal intestinal epithelium; 4 were composed of gastric mucosa. In 3 of the cases reported by A. L. Taylor, two were covered entirely with mucosa of intestinal type, one with gastric mucosa. Taylor refers to a case reported by Tillmanns in a boy of 13: a pedunculated tumour, the size of a walnut, increased in size after each meal, and in the course of a few minutes secreted 2 to 3 c.c. of clear fluid identical with gastric juice.

Many instances have been recorded in which vestiges of the vitello-intestinal tract at the umbilicus have shown heterotopic differentiation. Nicholson says: "Pyloric glands have been recorded in an umbilical polypus by Tillmans. Cardiac glands were found in the umbilical part of a patent vitelline duct by Salzer, and at the apex of a Meckel's diverticulum by Meulengracht. Brunner's glands are described by Kern in the extroverted distal end of a patent duct, and by Tschiknawerow at the apex of a Meckel's diverticulum. Wright found a small encapsulated pancreas in the subcutaneous tissue of the umbilicus of a girl of 12." The diversity of epithelial structure found in this situation is accounted for by the fact that in the early stage of development the vitelline duct was almost as wide as the whole of the primitive gut; so that there is no reason to suppose that the epithelium of the vitelline duct does not share all the prospective potentialities of the primitive gut.

22. Roser[81] reports a case in a man who had been operated upon for a tumour in the region of the umbilicus. A fistula persisted, and from this there was a slimy watery discharge. On examination it was found to pass into a cavity about 6 cm. in diameter. As much as possible of the lining

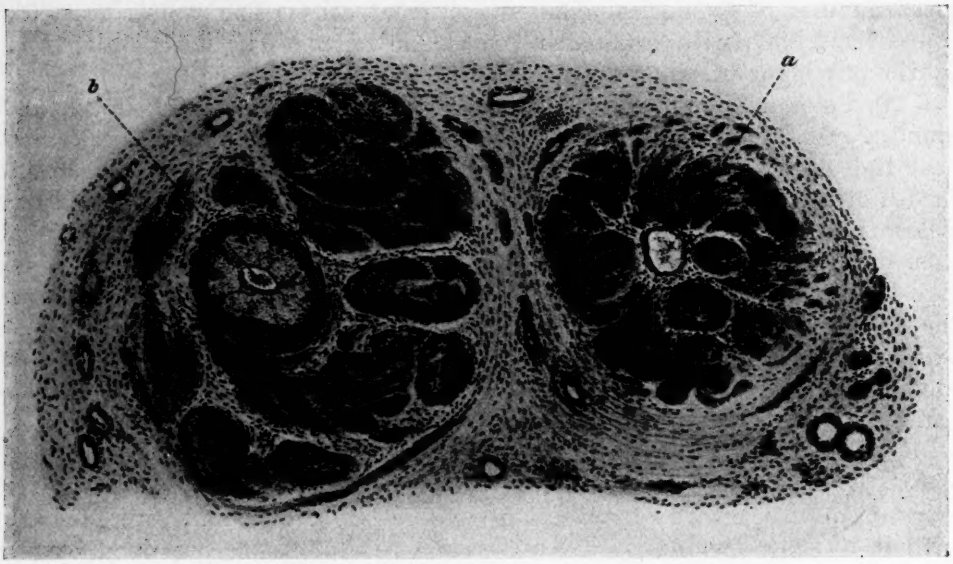

FIG. 53.—Section of fibrous band connecting cyst to umbilicus. *a* and *b* are the remains of the omphalo-mesenteric vessels, each containing blood and surrounded by unstriped muscle fibres. (*From Colmers, 'Archiv für klinische Chirurgie'*, 1906, lxxix.)

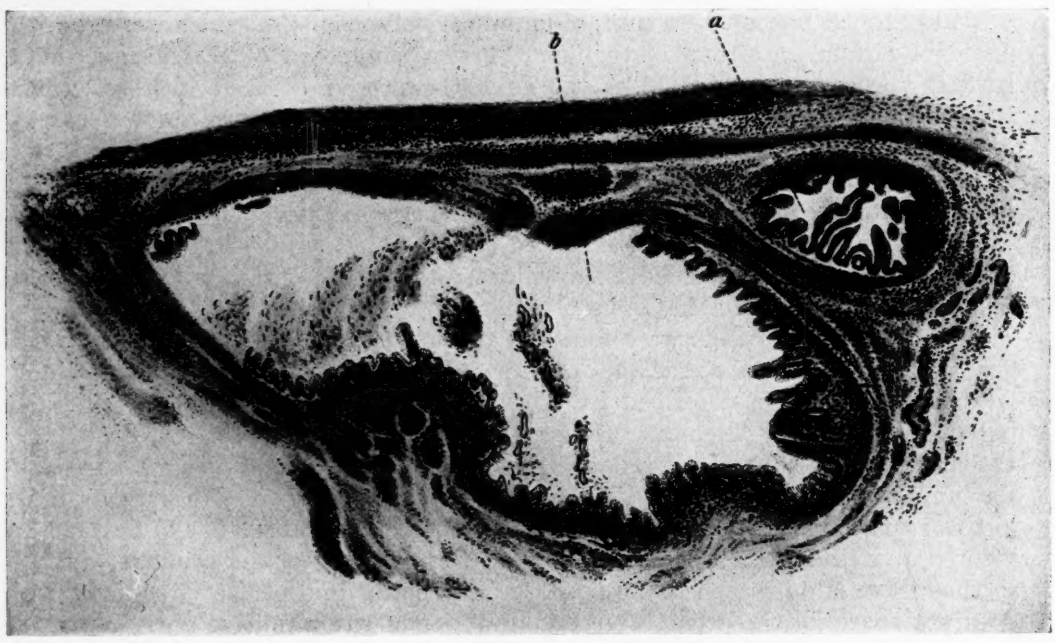

FIG. 54.—Same case as *Fig.* 53. Two prolongations (*a* and *b*) from a cyst near the umbilicus. Each is lined by tall cylindrical epithelium ; villi project into the lumen. This layer rests on a muscularis mucosæ ; and this on circular and longitudinal unstriped muscle fibres. (*From Colmers, 'Archiv für klinische Chirurgie'*, 1906, lxxix.)

was dissected out. The mucous lining was found to contain Lieberkühn's glands.

23. John H. Wright[82] reports in a female child, 12 years old, the occurrence of an umbilical fistula which had been present since birth. A. T. Cabot dissected this out, down to the level of the peritoneum. The peritoneal cavity was opened and explored; no connection of the fistula with the intestine could be made out. Microscopical examination showed "that the specimen for the most part consisted of dense connective tissue together with some fat tissue. The fistulous tract appeared to correspond to an invagination of the epidermis. In the midst of the substance of the specimen, at a point about 2 mm. from the apex of the invagination of the epidermis, an irregularly-shaped nodule, 3½ mm. in greatest diameter, was found. Microscopical examination of this nodule showed the structure of pancreas. Amongst the tubules were undoubted islands of Langerhans.

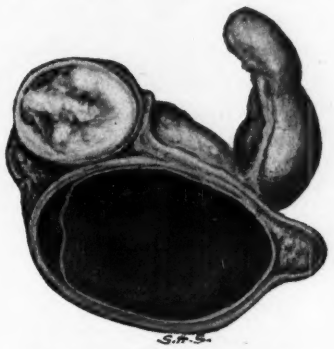

FIG. 55.—A developmental enterogenous cyst, situated in the great omentum. This may have been derived from the vitello-intestinal tract. (× 2.)

24. In a case recently operated upon at Westminster Hospital by Mr. Stanford Cade, for the radical cure of an inguinal hernia, the vermiform appendix was found occupying the sac. The appendix was removed. Exploration of the neighbouring peritoneal cavity revealed a small tumour in the great omentum (*Fig.* 55). This was excised. It proved to be a cyst lined by a layer of columnar ciliated epithelium; outside this were a muscularis mucosæ, a layer of connective tissue, and several layers of muscular fibres—some cut longitudinally, and others transversely. This is certainly a developmental enterogenous cyst. It may have been derived from the vitello-intestinal tract, have become completely detached from the parent gut, and grafted on to the omentum. (Cf. Struther's case, p. 70 and *Fig.* 52, and Roth's case, p. 55 and *Fig.* 39.)

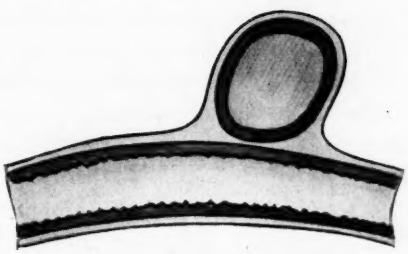

FIG. 56.—Medium sectum diverticuli, in formam cystæ, 10″ a valvula colli, in puellæ neonatæ, omnino bene formatæ, ileo, infixi, quod peritonaeo arcte circumclusum, iisdem membranis constabat, quibus intestina; muco perspicuo erat impletum. (*After Räsfeld, 'De Hernia Littrica Berol'*, 1852, 11.)

Räsfeld,[83] in his work on Meckel's diverticulum, noted this change from diverticulum to cyst so clearly that I quote a few of his sentences and copy his diagram (*Fig.* 56). "Rarissime fit ut latus intestini, in quo diverticulum inhæret, claudatur, diverticulum autem ipsum, partim modo evanescat, ita ut in cystæ formam in ileo insedeat."

Fitz[84] describes a specimen in the Warren Museum (No. 4903) found at the autopsy of a patient who died of chronic pleurisy. About one metre above the ileocæcal valve was a cyst of Meckel's diverticulum, 3 cm. in length and about 1 cm. in diameter. No communication could be found between it and the lumen of the intestine.

VERMIFORM APPENDIX.

Hedinger[85] described an autopsy on a child who died at birth, death being consequent on protracted labour due to hydramnios and transverse presentation. A small umbilical hernia contained a piece of large intestine and the vermiform appendix, the distal end of which was adherent to the hernial sac. The proximal portion of the appendix was normal; the distal

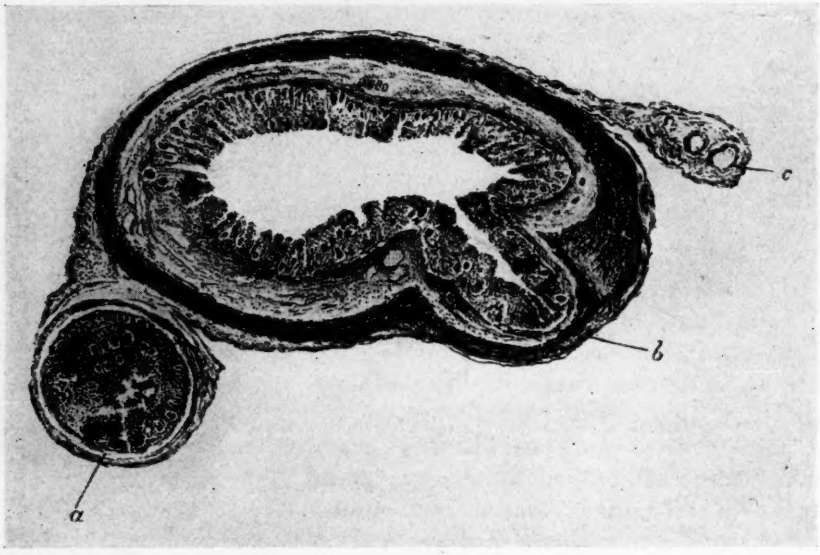

FIG. 57.—Multiple developmental diverticula of the appendix. *a*, Diverticulum of the appendix, appearing in this section as a separate structure attached to the appendix by serosa; a further section shows a common submucosa; other sections show a lumen common to *a* and to the appendix. *b*, Diverticulum extending to the muscular coat. *c*, Meso-appendix. (*From* '*Virchow's Archiv*', clxxviii, *Fig.* 1, page 172.)

third was greatly diminished in size and of peculiar uneven surface, studded with small knobs of various sizes, all subserous. Microscopical examination revealed many congenital diverticula (*Fig.* 57). In addition to these there were in the submucosa many areas of mucosal structure showing greatly branched Lieberkühn's glands with tall cylindrical epithelium.

SIGMOID.

Garnett Wright[86] described a diverticulum 37 in. long which commenced at the upper end of the sigmoid loop of the colon (*Fig.* 58). It ran at an acute angle downwards and entered between the layers of the mesosigmoid. Here it occupied the cavity of the sigmoid colon, and became of a very large size, being much greater in diameter than the bowel. On reaching the end of the sigmoid loop the diverticulum separated from the colon, to which up to now it was intimately adherent, and narrowing abruptly, passed from between the layers of the meso-sigmoid to lie behind the posterior parietal peritoneum.

FIG. 58.
Garnett Wright's case.

Here it turned upwards and expanded into a blind sac, reaching a position on the posterior abdominal wall behind the stomach. In the recent state the circumference of this portion of the diverticulum was 17 in. The diverticulum possessed two muscular layers, an outer longitudinal and an inner circular. The inner coat of the diverticulum consisted of a mucous membrane thrown into irregular folds lined by epithelium of the usual large-intestine type.

'REDUPLICATIONS.'

I think there can be little doubt that many cases recorded as reduplications of portions of the intestinal tract were either developmental diverticula or enterogenous cysts.

Fairland,[87] operating to relieve intestinal obstruction in a child born with an imperforate anus, opened the abdomen, withdrew a distended portion of gut, and opened this; a large quantity of fæces rushed out. At the post-mortem examination it was found that the opening had been made into a large diverticulum (*Fig.* 59 C), 13 in. long, which arose from the duodenum about 1½ in. from the pylorus. In this case the gut was said to have 'bifurcated', but there can be little doubt that the second portion of gut was a developmental diverticulum.

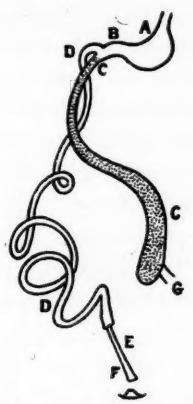

FIG. 59.—Fairland's case.

FIG. 60.—Lockwood's case.

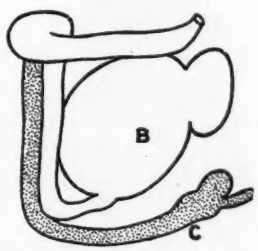

FIG. 61.—Meckel's case.

C. B. Lockwood[88] described the case of a man, age 57, who died of intestinal obstruction (*Fig.* 60). "At the post-mortem examination, the cæcum was found in the right hypochondriac region, beneath the liver. The colon crossed from the cæcum to the splenic curve, and thence descended into the pelvis. Here a remarkable abnormality occurred. The descending colon was double; the two tubes were upon the same plane, the smaller one nearer the vertebral column. Each possessed appendices epiploicæ. The tube which was nearest the spine had a very small canal in its centre, which appeared to have a mucous lining. This canal opened above into the colon by means of a small aperture; below, it was lost in a mass of malignant disease. It contained no fæces. Its walls were moderately thick. The malignant mass which received the end of the diverticulum also concealed the end of the outer tube, which was the colon proper. It is very hard to imagine how a tube which is at first single can afterwards become double. Meckel[89] has pictured the intestines of a fœtus in which there were two cæca (*Fig.* 61). The ileum

opened into B, and from it the gut extended upwards towards the hepatic curve. Below this cæcum was another, C, from which a tube extended parallel to and outside the first, and also continuous with the transverse colon, at the hepatic curve. Meckel[90] also figures a case in which the cæcum was bifid." Commenting on Lockwood's case, Dr. Symington, of Edinburgh, remarked that one of the two tubes in the position of the descending colon might be a diverticulum, there being no proof that they united below.

Fitz[91] recorded a case of "intra-mesenteric duplication of the intestine" (*Fig.* 62). "Two more or less parallel intestinal tubes, cut transversely across in their continuity, are contained within a single mesentery. The blood-vessels of the latter terminate in the wall of the outermost tube, first supplying branches to the inner tube. The diameter of the outer tube is relatively uniform throughout, while that of the inner, in general somewhat narrower, becomes dilated in the immediate vicinity of an opening through which the canals of the tubes communicate with each other. The contiguous portions of the walls of the two tubes are in close proximity to each other throughout the greater part of their course, and are fused near the common opening. The walls are composed of mucous, muscular, and peritoneal coats. The mucous membrane of the outer tube shows slightly projecting transverse folds in the vicinity of the opening, while that of the inner tube is relatively smooth. Villi and crypts are present in both. The opening between the tubes is rounded, sharply defined, one-third of an inch in diameter, and appears to be covered by mucous membrane. The canal of the inner tube is contracted in the immediate vicinity of the opening, and its wall at this part is thickened and fibrous." I think this is a case of developmental enterogenous diverticulum which, on reaching the outer surface of the parent gut, extended orally and aborally. Unfortunately no record was made of the length of the diverticulum.

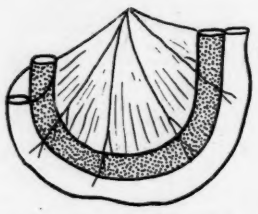

FIG. 62.—Fitz's case.

A glance at Roth's case (*Fig.* 63; *see also Fig.* 40), I think, enables one to understand more clearly the development of the case described by Fitz.

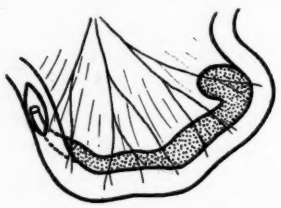

FIG. 63.—Roth's case.

In Roth's case we have an undoubted developmental diverticulum. This on reaching the serous surface of the parent gut extended aborally along it for a distance of 10 cm. Had it bifurcated at its commencement and extended orally as well as aborally the resulting condition would have been similar to that figured by Fitz.

In the Royal College of Surgeons Museum, Specimen No. 1222.1 is "a piece of small intestine of an ox to one side of which there is intimately attached a long tubular cyst, 17 in. in length, and of the same calibre as the intestine itself; the groove between the two, on the free aspect, is filled with fat. At either end the cyst terminates blindly, and for a short distance is unconnected with the gut (*Figs.* 64 and 65). In the recent state the cavity was filled mainly with epithelium. Microscopical examination shows that the

cyst is furnished with a double muscular wall, and a mucosa with muscularis mucosæ, but without lymphatic tissue. The mucosa bears no villi or papillæ, and is invested with a stratified epithelium devoid of a stratum granulosum. The cyst has probably arisen in the omphalo-mesenteric duct, the original columnar epithelium of which has become transformed into the kind mentioned." I think, as in Fitz's case, this cyst originated in a developmental diverticulum, which, on gaining the surface of the parent gut, bifurcated and extended orally and aborally. That the two ends of the cyst are not connected with the gut confirms this suggested mode of origin.

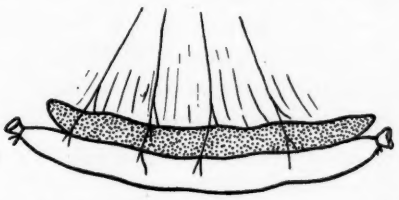

FIG. 64.—Specimen in R.C.S. Museum (No. 1222.1).

FIG. 65.—A piece of small intestine of an ox, to one side of which there is intimately attached a long tubular cyst. (× ¼.) (*R.C.S. Museum*, No. 1222.1.)

Garnett Wright's case (*Fig.* 58) so closely resembles Roth's case that I think it should be assigned to the group of developmental enterogenous diverticula.

Pritchard's case, to which reference has already been made, is that of a second stomach situated behind the peritoneum. This, I consider, started as a developmental diverticulum from the fore-gut, which, becoming detached, formed an enterogenous cyst. The same origin must be ascribed to Ahrens' case in which, behind the peritoneum, was found a cyst which resembled an hour-glass stomach and 26 cm. of small intestine. Microscopical examination of the cyst wall revealed a structure identical with that of a stomach and of small intestine, save that the mucosa in different sections consisted of " stratified and cuboidal cells, stratified ciliated cells, tall columnar, and flat cells." These two cases well illustrate the potentialities of a small isolated portion of the fœtal entoderm. So, too, does the following description of the distal end of a vitello-intestinal tract.

Nicholson[6] reports a specimen removed from a boy of 8. It consists of a narrow tube, about 2 cm. in length, the distal half of which is gradually dilated to form a funnel-shaped organ, which opened on to the base of the umbilicus without, as is frequently the case, having undergone eversion. The proximal end was attached to a coil of small intestine, identified as ileum.

" The mucous membrane of the proximal end of the duct is identical with that of the lower part of the small intestine.

" The widened distal end of the duct is lined by a highly differentiated and beautifully finished fundal mucous membrane. Where the duct becomes narrowed to pass into its intestinal portion the fundus is separated from the iliac mucous membrane by a narrow pylorus. This consists of masses of large coiled glands, whose efferent superficial segments pursue an irregular course between the fundal glands, to open upon the surface among them. The line of union between the gastric and intestinal epithelium upon the surface of the duct is sharp and abrupt. Pyloric glands extend for a short distance into the beginning of the intestinal mucous membrane. Here they occupy its deep surface beneath the crypts of Lieberkühn. They thus appear to correspond with Brunner's glands, although they do not penetrate the muscularis mucosæ. The last-named structure consists of a regular sheet of plain muscle fibres, which is thickened beneath the ring of pyloric glands to form a sphincter. A glance at *Fig.* 66 demonstrates the highly organized structure and morphological finish of this small ectopic stomach, with its broad fundus and its narrow pylorus. Not only is its structure perfect, but there is evidence that its physiological secretion was identical with that of the stomach."

FIG. 66.—Meckel's diverticulum 2 cm. long. The distal end, lined by fundal and pyloric mucosa. (*From the 'Journal of Pathology and Bacteriology'*, 1923, xxvi.)

Nicholson records another narrow Meckel's diverticulum, about 15 cm. in length. " The greater part of this is lined by a perfectly differentiated fundal mucous membrane, whose semi-digested condition proves the presence of a secretion analogous to the gastric juice."

EPITHELIAL MISPLACEMENTS.

Indirect evidence of the common occurrence and widespread distribution of fœtal diverticula is afforded by a study of the epithelial misplacements of the alimentary tract. The reader is referred to most illuminating writings on this subject by G. W. Nicholson[92] (" Heteromorphoses of the Alimentary Tract ") and by A. L. Taylor[57] (" Epithelial Heterotopias of the Alimentary Tract.")

Taylor, working with the material obtained in two years from the operation theatres and the post-mortem room of the Leeds General Infirmary, found 69

cases of epithelial misplacement in the intestinal epithelium. In a series of 81 cases reported by him, the type of epithelium misplaced and the situation in which it was found are shown in the following table :—

Type of Misplaced Tissue	Region Affected	No. of Cases
1. Superficial heterotopia		
a. Gastric	Œsophagus	6
	Duodenum	2
	Small intestine	1
	Meckel's diverticulum	5*
	Umbilicus	1
b. Intestinal	Stomach	36
	Umbilicus..	3†
c. Duodenal	Stomach	1
2. Deep heterotopia		
a. Submucous glands ..	Stomach	1
b. Intramural cysts ..	Stomach	1
c. Adenomyoma ..	Stomach	6
	Duodenum	3
d. Accessory pancreas	Stomach	6
	Duodenum	7
	Jejunum	3
	Meckel's diverticulum ..	3
	Total ..	81

* Includes the three cases in which heterotopic pancreas was also present.
† Includes the case showing gastric type heterotopia.

Seeing that 69 of these cases were obtained in two years from the operation theatre and the post-mortem room of the Leeds General Infirmary, it is safe to assume that if minute routine examination of the whole alimentary tract were the invariable rule, heteromorphoses of the intestinal tract would prove to be of fairly frequent occurrence.

Nicholson, in his studies of the heteromorphoses in the human body, says that " they can be all referred to anomalies of differentiation ; cell differentiation is, within wide limits at all events, the result of stimulation from without, of environment in fact. When this is normal, differentiation will inevitably be so too ; when cells are exposed to abnormal influences they will as inevitably undergo differentiation in an abnormal direction." " The entodermal cells lining any 'bud' from the primitive intestinal tract possess all the potencies of the gut of which they have barely ceased to form a part. But in the very process of budding their environment alters. They are thus forced to develop certain of their original potencies and to suppress others. By so doing the immediate environment—the stimuli, internal as well as external, to which these are subjected—is again altered. If the sequence of stimuli or changes of environment is orderly the cells will, in the fullness of time, acquire the structural characters of pancreatic tissue or of liver tissue. If it be interrupted and altered to an extent to which the cells can only respond by the development of some other of their original potencies, an abnormal or heterotopic tissue must result."

A specimen described by Lewis and Thyng illustrates this. They observed in a 41·6-mm. rabbit embryo a single diverticulum. It possessed an oval lumen which emptied into the intestine. It was lined with smooth epithelium, contrasting with the much enfolded intestinal layer which was in process of forming villi. These writers state: "It is well known that a small pancreas may develop at various places along the lumen of the small intestine. We have examined four such cases—one from the duodenum, two from the jejunum, and one from the umbilicus. The position of these structures accords with that of the early diverticula."

A. T. Lewis[93] says it is possible that accessory pancreases sometimes develop in relation with embryonic intestinal diverticula. In the embryo to which reference has already been made (*see Fig.* 23) it was noted that a small cyst, obviously derived as a diverticulum from the duodenum, was situated in the mesenchyme. In this same specimen was a diverticulum of the duodenum situated above the dorsal pancreas. Below the duct of the dorsal pancreas was another elongated, unbranched diverticulum 0·55 mm. long and about 0·07 mm. in diameter. This outgrowth had a distinct lumen, and was somewhat expanded at its distal extremity, where the cells were of the same nature as those of the other portions of the pancreas. In the small detached cyst, however, the epithelium of the cyst which corresponds with the accessory pancreas was quite unlike that of the pancreas. The pancreatic tubules, about 0·05 mm. in diameter, contained only a minute lumen, whereas the cyst had a cavity 0·22 mm. in diameter, equal to that of the intestine. Beyond the diverticulum with pancreas at its distal extremity there were eighteen diverticula along the anterior limb of the intestinal loop. In this single specimen we have nineteen simple diverticula of the intestinal wall, one elongated diverticulum containing pancreatic structure at its tip, and a cyst—derived from a diverticulum—the lining cells of which differed from the entoderm of the neighbouring intestine and from the pancreatic cells.

I think there can be no doubt that the cells lining developmental enterogenous diverticula and cysts are exposed to influences which differ from those to which the adjacent normally situated cells are exposed; hence they are likely to differentiate into cells which differ from those in their immediate vicinity.

The association of heterotopic tissue with diverticula has been frequently observed, and one is driven to the conclusion that such conditions as that which follows must have originated in the diverticula of the fœtal entoderm. A. L. Taylor[75] reported the case of a woman, age 52, who died of carcinoma of the rectum. On the posterior wall of the œsophagus at the level of the cricoid cartilage was a small whitish area about $\frac{3}{8}$ in. long, one margin of which showed a definite break in the epithelium. Microscopically this is found to be the mouth of a small flattened diverticulum or pocket in the mucous membrane, with edges closely apposed to each other. This pocket is surrounded everywhere by a thick muscularis mucosæ, and does not protrude for any distance into the submucous tissues. Its walls are lined by gastric glands entirely of cardiac type, some of them much dilated and containing cell débris or secretory products. The transition from œsophagus to gastric epithelium takes place abruptly at the mouth of the diverticulum.

Taylor also described a small diverticulum on the posterior wall of the duodenum. The diverticulum, of irregular shape, was about ¼ in. across and directed obliquely towards the pylorus. The floor of the diverticulum was lined by gastric (fundal) mucous membrane, and beneath this the submucous glands were absent. Distal to this, and about ½ in. from the pylorus, was a small whitish patch. This, being microscoped, proved to be a patch of fundal glands lying in the duodenal mucosa. It was confined to the inner side of the muscularis mucosæ, beneath which the submucous layer was devoid of Brunner's glands.

We may hence conclude that apart from the enterogenous cysts which are derived from the vitello-intestinal tract, the cysts of similar structure which are found in the abdomen or in the thorax originated in the diverticula which are found in the fœtal entoderm, as described by Keibel and by Lewis and Thyng. Most of these diverticula disappear; some persist. Of those that persist, some become lined by epithelium which differs from the immediately adjacent epithelium and resembles that of some other portion of the intestinal tract: these are the superficial and deep heteromorphoses. Some develop into gross diverticula, and others into closed cysts: these are the developmental enterogenous diverticula and cysts. Such diverticula and cysts are usually lined by epithelium similar to that lining the adjacent gut, but occasionally they are the seat of superficial or deep, or of both superficial and deep, epithelial heteromorphoses.

SUMMARY.

The cyst here recorded, one of the group commonly designated 'ileocæcal cysts', is a developmental enterogenous cyst. All cysts found in the abdomen, or in the thorax, or at the umbilicus, having the structure of gut, must have been derived from the primitive intestinal tract; they are developmental enterogenous cysts.

These cysts originated either in the vitello-intestinal tract, or in the diverticula which are found in the developing entoderm of the embryo, as described by Keibel, and by Lewis and Thyng.

Some of these developmental diverticula persist as diverticula, and increase in size.

Instances are given of enterogenous cysts which originated in developmental diverticula situated in those segments of the primitive intestinal tract which later became œsophagus, stomach, duodenum, jejunum, ileum, ileocæcal region, vermiform appendix, or sigmoid; also of enterogenous cysts which originated in some unobliterated portion of the vitello-intestinal tract.

The great variety shown in the structure of the inner lining of these cysts is in some cases accounted for by intracystic pressure, in others by inflammatory changes, and in many by an error in differentiation of the lining cells resulting in heteromorphosis of the epithelium.

It is probable that all the epithelial misplacements of the intestinal tract, whether occurring in enterogenous cysts, in developmental diverticula, or as the superficial and deep heteromorphoses of the intestinal tract, originated in the diverticula which are found in the developing entoderm of the embryo.

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HÆMANGEIOMATOUS CYSTS OF THE CEREBELLUM.

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That cerebellar cysts frequently have a small knot of tumour in their walls has been known for half a century. In 1872 Hughlings Jackson[1] found in the wall of a cerebellar cyst a tumour, the size of a shilling on its cut surface, which extended to the surface of the cerebellum. He noted that the inner surface of the tumour protruded into the wall of the cyst without any covering by cyst wall. Since that time a large number of cases has been recorded in which cerebellar cysts have had a tumour in their walls. Many of these tumours have been called gliomas, and others angeiosarcomas on microscopic examination; but within recent years it has become clear that a large proportion are hæmangeiomas. This fact is of importance from a surgical point of view, for cerebellar hæmangeiomas are the most benign of intracranial growths, and the removal of such a tumour from the wall of a cyst should in most cases result in the cure of the patient.

In a recent monograph Lindau[2] has reviewed all the recorded cases of cerebellar cysts and has added to them a number of fresh cases, some recent, and some old specimens from museums in Scandinavia, Germany, and Czechoslovakia. He divides cerebellar cysts into six classes: (1) *Dermoid cysts and cholesteatomata;* (2) *Cysts formed as a result of hæmorrhage or softening;* (3) *Parasitic cysts;* (4) *Cysts in relation to a tumour;* (5) *Simple cysts;* (6) *Cysts in communication with the 4th ventricle.* To make the subject complete from a surgical standpoint we might add to these classes two forms of extracerebellar cyst, viz., cystic acoustic nerve tumours, and meningeal cysts caused by arachnoid adhesions. It is our present purpose to consider Lindau's Class 4, i.e., cysts in relation to a tumour, and to discuss whether his Class 5 exists, i.e., whether simple cysts may arise as a developmental anomaly apart from tumour growth.

It is quite impossible in reviewing the literature of cysts in relation to a tumour to say how many of these tumours are angeiomas and how many are gliomas. There is no doubt, however, that these two forms of growth are those most commonly responsible for intracerebellar cysts. It is not possible in many cases to distinguish with the naked eye between these two forms, nor is it possible in reviewing the literature to say how many of the recorded tumours should be allocated to either class. We might be tempted to accept the microscopical diagnosis attached to each tumour were it not for the fact that in some instances the histological appearance revealed by the illustrations is quite at variance with the diagnosis given. It is to be noted also that the term 'angeioma' does not appear in the literature of the subject until 1923. While we cannot say definitely that angeiomas are the commonest form of tumour in relation to cerebellar cysts, our own experience suggests that they are. In a recent paper Dandy[3] reports seven cases of angeiomatous cerebellar

cysts, and expresses the view that in his operative experience they occur about as frequently as gliomatous cysts of the cerebellum.

Lindau has found 16 angeiomas and 8 gliomas in relation to cerebellar cysts. Our collection at the National Hospital, Queen Square, since the year 1914, includes 7 angeiomatous cysts (one bilateral) and 2 gliomatous cysts. These figures suggest that angeiomatous cysts are at least twice as common as gliomatous cysts in the cerebellum. In addition, both Lindau and we ourselves have found solid rounded angeiomas occurring as multiple growths in relation to the cerebellum and pons. These tumours have an identical structure to those in the wall of cysts and must be considered along with them.

An interesting point which has been brought to light by Lindau in relation to angeiomas of the cerebellum is the frequency with which they are associated with angeiomas or angeiomatous cysts elsewhere in the body. Angeiomatosis of the retina was present in two of his cases,* and has been seen also by Cushing and Bailey[4] and by Seidel[10] in cases of cerebellar cysts.† In other cases angeiomas of the spinal cord or medulla, cysts of the pancreas, hypernephromas, cavernous angeioma of the liver, or cystic kidneys have been found in patients who have died as a result of angeiomatous cysts of the cerebellum. This combination of cystic tumour of the cerebellum with angeiomas or cysts in other organs clearly demonstrates the congenital nature of the tumours. We have not been able to confirm Lindau's observations in this matter, possibly owing to the partial nature of the post-mortem examination allowed in our cases. It may however be said definitely that in none of our seven cases was an angeioma of the retina visible on ophthalmoscopic examination.

CASE HISTORIES.

Case 1.—(This case was reported in *Brain*, 1919, as an atypical endothelioma.[5])

W. B., a soldier, age 31, was admitted to the National Hospital, Queen Square, in April, 1918. He had, for about six months, been feeling giddy, especially during the morning parades. For three months he had also had severe headaches and his sight had been failing. His speech had become of a staccato character. He gave a history that a brother and a sister had 'died of the same thing' at the ages of 27 and 26.

On Examination.—Except for an unsteady gait, he presented very slight signs of cerebellar disease. There was no nystagmus, and his co-ordination was nearly perfect, but on alternate movements his right arm and leg were slightly clumsier than the left. There was no alteration of the reflexes or of sensibility. Lumbar puncture gave a clear fluid containing 0·15 per cent protein, but no cells. The Wassermann reaction was negative in the blood and cerebrospinal fluid. He became gradually worse, becoming subject to fainting fits, in one of which he died three months after admission.

Autopsy.—A post-mortem was made and the brain fixed in formalin before it was examined by us. On hemisection of the fixed brain in the sagittal plane, an irregularly shaped cavity was seen lined with a thick yellow membrane which was easily detachable from the brain substance. This cavity ran from the roof of the fourth ventricle up behind the mid-brain to the pineal body, from which it was separated by a layer of pia mater. As it passed downwards to the upper surface

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* In one it could only be seen on microscopical examination.

† A similar case in which the patient and two other members of his family suffered from angeiomatosis retinæ has been reported by Rochat (*Klin. Monatsbl. f. Augenheilk.*, 1927, lxxviii, 601).

of the cerebellum it became embedded 4 mm. below the surface. It passed rather higher on the left side of the brain-stem, reaching the left corpus geniculatum internum. On the right side it passed backwards and outwards into the upper part of the right cerebellar hemisphere. It presented four openings in the middle line and many divarications in the substance of the cerebellum. Its antero-posterior diameter was about 5 cm. and its transverse diameter 3·5 cm. A small rounded tumour was found in the left wall of this cyst. In addition there were two other tumours, one embedded in the cortex on the under surface of the cerebellum at the junction of the posterior end of the inferior vermis with the left lateral lobe. This was a rounded reddish tumour, rather granular on its surface, and measuring 10 mm. It was surrounded on its upper surface by a small cystic space, the walls of which appeared to be formed of smooth, slightly reddened brain tissue. A similar much smaller tumour was found on the right hemisphere near the postero-inferior surface and about 1 cm. from the mid-line. It measured 2 mm. in diameter. (*Fig.* 67.)

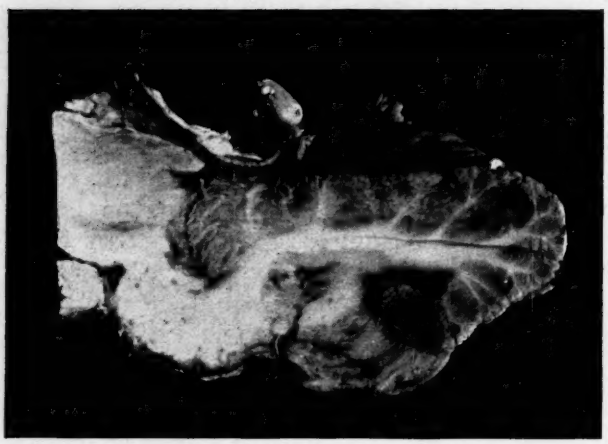

FIG. 67.—*Case* 1. Paramedian sagittal section of cerebellum, pons, and mid-brain, showing one tumour on the upper surface and one near the lower surface of the cerebellum. A small cyst is seen in relation to the lower tumour.

Microscopically, the larger tumour was definitely outlined by a thin zone of connective tissue, outside which the cerebellar cortex appeared to be rather compressed, but not otherwise abnormal. This connective-tissue capsule was not present around the smaller tumours. The tumours themselves consisted of a network of capillary vessels, lined by flattened endothelium between which lay larger endothelial cells with oval nuclei and scanty rather granular or foamy cytoplasm. A fine network of connective-tissue fibres reinforced the walls of the capillaries and was condensed in several concentric layers around the numerous large sinus-like spaces, which apart from this had no definite walls. In the smaller tumours some of the endothelial cells had larger bodies containing vacuoles of fairly large size, and in some areas all the cells were greatly swollen and foamy with small eccentric nuclei.

The lining membrane when examined was seen to consist of nervous tissue, in places degenerated and in other places reinforced by collagen strands. It contained numerous granules of blood-derived pigments.

This case is of special interest on account of the family history, which caused an original diagnosis of " familial cerebellar ataxia with papillœdema " to be made. It is possible, although it cannot be proved, that the brother and sister also suffered from hæmangeiomas of the cerebellum. The large cyst in the upper part of the cerebellum had been emptied before fixation and was somewhat distorted by the weight of the cerebellum which lay over it. Consequently its appearance cannot be taken as representing in any way its shape during life, when it probably formed a more or less rounded mass rising from the upper surface of the cerebellum. The tumours were otherwise typical capillary angeiomas, so much so that this case was at once recalled when the tumour in *Case* 2 was seen five years later.

Case 2.—W. C., age 25, was admitted to the National Hospital, Queen Square, in December, 1922, under Dr. Kinnier Wilson. He had had, in 1918, a wound of the face by a bullet which entered just external to the left eyebrow and emerged below the lobe of the right ear. After this he felt quite well till August, 1922, when he found that on rising in the morning he felt dizzy and had a 'terrific pain' at the back of the head. These headaches became more frequent and more persistent, and he also had pain over the eyes. During the three weeks before admission vomiting had occurred with the headache on several occasions. Twice he had had a sensation on looking to the left as if objects in that direction were flickering up and down.

On Examination.—No nystagmus could be made out, and beyond definite swelling of both optic discs, and unsteadiness in walking and on standing, there was no alteration in his physical condition. He died on Feb. 9, 1923, and a post-mortem examination was made of the brain only. No external tumour could be seen, but there was evident hydrocephalus. On section of the cerebellum a cyst was found which spread across the right half of the cerebellum from its outer edge to the white matter of the middle peduncle, and was about the size of a pigeon's egg (*Fig.* 68). On the outer border of this cyst a small round firm tumour was seen. It had a mottled surface and was adherent to the cerebellar cortex.

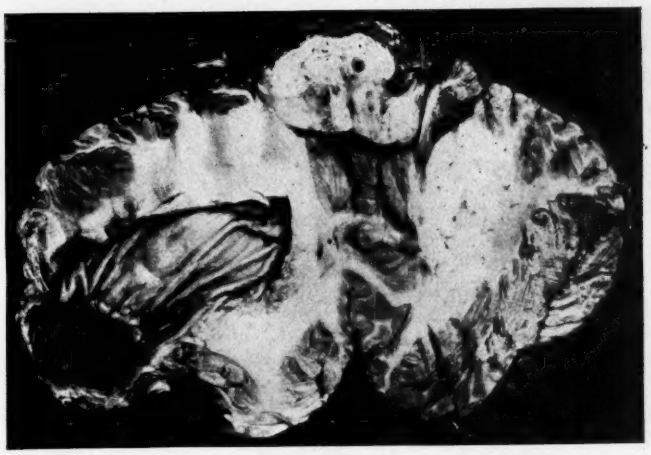

Fig. 68.—*Case* 2. Horizontal section of cerebellum looked at from below. Tumour and cyst are seen in the right hemisphere. The dentate nucleus lies close to the cyst wall.

Histologically this tumour resembled very closely those in *Case* 1; like them it contained large sinus-like spaces lined by an endothelial layer and supported by an irregularly concentric condensation of fibrous tissue. A connective-tissue capsule surrounded part of the tumour, but elsewhere this was absent. The tumour had, however, everywhere a very definite margin, as the capillary loops of which its edge was composed ceased along a curved line. Near the inner margin of the tumour was a small cyst containing clear, colloid material. The outer wall of this cyst was formed by a thick zone of connective-tissue fibres, but its inner wall—that is, the wall towards the centre of the tumour—was simply formed of tumour tissue. With Scharlach R. staining almost every one of the larger endothelial cells in the tumour was seen to contain a mass of fatty granules, a few of which had small anisotropic specks among them.

This case was in every way typical. The interval of four years between the wound and the onset of symptoms makes the connection between the trauma and the beginning of the cyst formation rather indefinite. But in view of the close relationship which existed in our *Case* 5 between the injury to the head and the onset of symptoms, the possibility of a similar relationship in this case must be borne in mind.

Case 3.—Rose W., age 33, was admitted to the National Hospital, Queen Square, under Dr. Grainger Stewart on Sept. 20, 1926. She had suffered for four months from occipital headaches and vomiting, which had been coming on in the morning with increasing severity. She had at times seen double, but not constantly. Her walking had become unsteady and she felt giddy almost all day. Recently her sight had failed considerably, and she had not been able to write properly for six weeks.

On Examination.—It was found that she was rather slow-witted and lethargic. Her memory, however, was good and her speech normal. There was severe papillœdema on both sides with hæmorrhages into the surrounding retina. Her visual acuity was 6/6, but the fields of vision were somewhat restricted. When she looked to the extreme left she had diplopia and a few nystagmoid jerkings were seen, scarcely meriting the name of nystagmus. There appeared to be slight weakness of the right side of the face, and her head was turned slightly to the right with the chin tilted in the same direction. Sensibility to all forms of stimuli was perfect, and the voluntary power of all limbs was good. There was, however, some loss of tone in the left arm and inco-ordination of both arms, especially the left. Some inco-ordination of movement was also present in the legs. The reflexes were normal. A decompression operation over the posterior cranial fossa was performed a week after admission. The patient died on the same day.

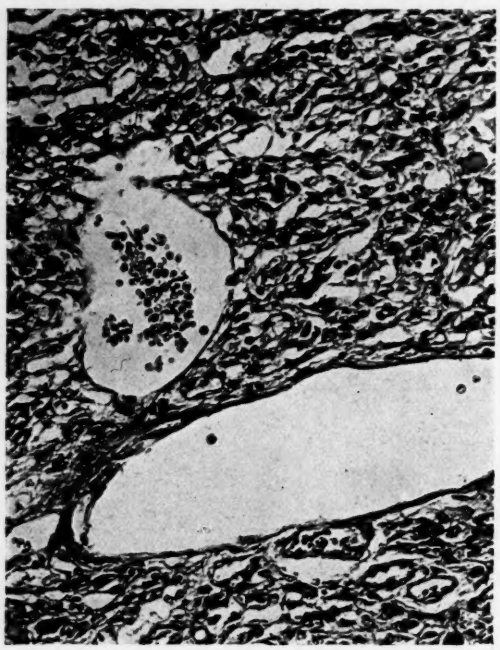

Fig. 69.—*Case* 3. Section of the tumour showing large blood spaces, and a few large darkly staining nuclei.

Autopsy.—At the post-mortem a smooth-walled cyst containing clear yellowish fluid was found in the right cerebellar hemisphere near the postero-internal surface. It could be seen from the surface through the thin and translucent cortex. Microscopically it was found to have no lining membrane, the wall being formed by a very slight neuroglial condensation. Elsewhere the cerebellar tissue looked normal.

There was a dimple-like depression in the postero-inferior wall, and on section through this a very small rounded knot of tumour tissue about the size of a lentil was found. This proved to be a capillary angeioma, almost exactly similar in histological structure to those already described. There was, however, no definite connective-tissue capsule round it. It contained some large sinus-like spaces with no definite wall except an endothelial layer based on the thin walls of the surrounding capillaries. Many of the endothelial cells lying between the capillaries had large, darkly staining, elongated nuclei, and others contained a clump of several rounded nuclei. Both these appearances were interpreted as degenerative types of cell. (*Fig.* 69.)

Case 4.—Zillah J., age 30, was admitted to the National Hospital, Queen Square, under Dr. Adie, on Aug. 21, 1926. For about a year she had had severe pain in the top of the head whenever she bent down, but, except for this, had had no headache until the last two months. About Easter, 1926, a grinding noise in the left ear had come on and persisted for four months. For the last two months the pain in her head had been more severe and had come on frequently in the morning

on waking. She also began to have attacks of giddiness when walking in the street and occasionally felt faint. For the last five weeks she began to have pain also in the back of the neck. Her eyesight had become misty, and she often saw double. She had had occasional attacks in which she felt faint, but had never actually lost consciousness.

On Examination.—She appeared to be well and cheerful. She carried her head turned slightly to the right and tilted slightly backwards. She complained of pain and stiffness in the neck, but there was no limitation of movement of the head. Severe papillœdema was present in both eyes. Very slight, fine, and rapid nystagmus was present on deviation of the eyes to the right, and a few arrhythmic jerks occurred on deviation to the left. There was hypotonia and inco-ordination of both arms and legs, most pronounced on the left side. The reflexes were normal.

A craniotomy over the left cerebellar hemisphere was performed on Sept. 3, by Mr. Donald Armour, and a large cyst in the left lateral lobe of the cerebellum was found and emptied. After this operation she was very much better and remained fairly well during 1927. But in March, 1928, her walking again became unsteady and her speech hesitant and snuffling. Headaches also became more frequent.

She was re-admitted to the National Hospital on June 13, 1928.

On Examination.—Her optic discs were found to be pale and slightly cupped. Her vision was fair, 6/12 right and left. Her external ocular movements were full, but there was nystagmus on turning the eyes to either side. Both arms, but especially the left, were atonic and ataxic. There was loss of tone also in the legs, and ataxia of the left leg. Sensibility, motor power and reflex functions were unimpaired. Her gait was very ataxic and reeling. There was a tense hernia at the site of the previous craniotomy.

A second operation was performed on June 20, at which a cyst was tapped in each cerebellar hemisphere. The patient died three days later.

Autopsy.—At the post-mortem a fairly large cyst was present in the left cerebellar hemisphere and a smaller cyst in the right. That in the right hemisphere passed forwards to the outer aspect of the dentate nucleus, while that in the left reached to about 4 mm. from the roof of the 4th ventricle internal to the dentate nucleus. It was bounded internally by the mid-line of the cerebellum. On careful examination of the cyst walls, which were otherwise smooth and colourless, a small dimple was found in the postero-external wall of each cyst, and at the bottom of this a small rounded reddish tumour was found. That in the right hemisphere measured 7 by 4 mm.; that in the left hemisphere 4 by 2 mm.

Fig. 70.—*Case* 4. Section of edge of tumour. Capillary loops are seen passing into normal neuroglial tissue.

Histologically these tumours were capillary angeiomas and resembled very closely those already described. They were entirely without any connective-tissue capsule; their edges, however, were fairly sharply defined, the capillary loops of which the tumour was formed ceasing along a regular line (*Fig.* 70). The larger tumour was unusual in that it surrounded and apparently enclosed an area of nervous tissue, which showed signs of degeneration but was easily recognizable as cerebellar cortex.

It was not possible to tell whether this piece of cortex was completely surrounded by tumour, as it was impossible to make serial sections through the whole thickness of the tumour. Throughout the larger tumour the connective-tissue septa were rather thicker than in the others, but otherwise the histological differences were very slight. Foamy cells were abundant (*Fig.* 71), and many large multinucleated giant cells were also seen between the capillaries. The walls of the cysts consisted of condensed neuroglial fibres, among which were many swollen neuroglia cells.

FIG. 71.—*Case* 4. Section of the tumour showing numerous large foamy cells.

Case 5.—John A., age 57, was admitted to the National Hospital, Queen Square, under the care of Dr. Kinnier Wilson, on June 22, 1928. About a year before he had slipped and fallen on the back of his head. He was dazed but not unconscious at the time, and felt no severe after-effects. But three months before admission he began to suffer from occipital headaches. About 10 days before admission he began to have attacks of vomiting, and later had had a buzzing noise in his ears. During the last week he had become weak on his legs and was no longer able to stand alone. His vision had become blurred, but he had never seen double.

ON EXAMINATION.—The patient was drowsy and slow-witted. There was no swelling of the optic discs nor true nystagmus. There was some reduction of sensibility to pinprick on the area of the face supplied by the 2nd and 3rd divisions of the right trigeminal nerve, and some weakness of the lower half of the right side of the face. Voluntary movements of the arms and legs were performed slowly and deliberately, but there was no weakness or ataxia. There was no alteration of sensibility or of the deep or superficial reflexes.

A cerebral decompression was performed by Mr. Donald Armour on July 10, but the patient only survived for a few hours.

AUTOPSY.—The post-mortem revealed a large pressure cone of cerebellum which reached far down through the foramen magnum on the left side. A cyst was found on the under surface of the left cerebellar hemisphere which ruptured as the brain was being removed from the skull. The lateral and third ventricles were considerably dilated. On section (*Fig.* 72) after hardening, this cyst measured 4×3 cm. in its horizontal diameter and was about 2 cm. deep. It lay external to the dentate nucleus, which was compressed inwards and forwards, and it had thinned out the cortex of the outer and lower part of the hemisphere. At its outer and inferior pole was a reddish oval tumour which measured $10 \times 7 \times 5$ mm. On cross-section the centre was more yellow than the surface. The upper surface of the tumour lay free in the cyst, the lower surface embedded in the cortex.

Histologically (*Fig.* 73) the tumour was a capillary angeioma, very similar to the others described. The large sinus-like spaces were walled by a condensation of the connective tissue which formed the frame-work of the tumour, but minute capillaries could be seen throughout this wall and were even found in its innermost layers. Almost all the endothelial cells lying between the capillaries were honeycombed with spaces which with Scharlach R. staining were seen to contain globules of fat.

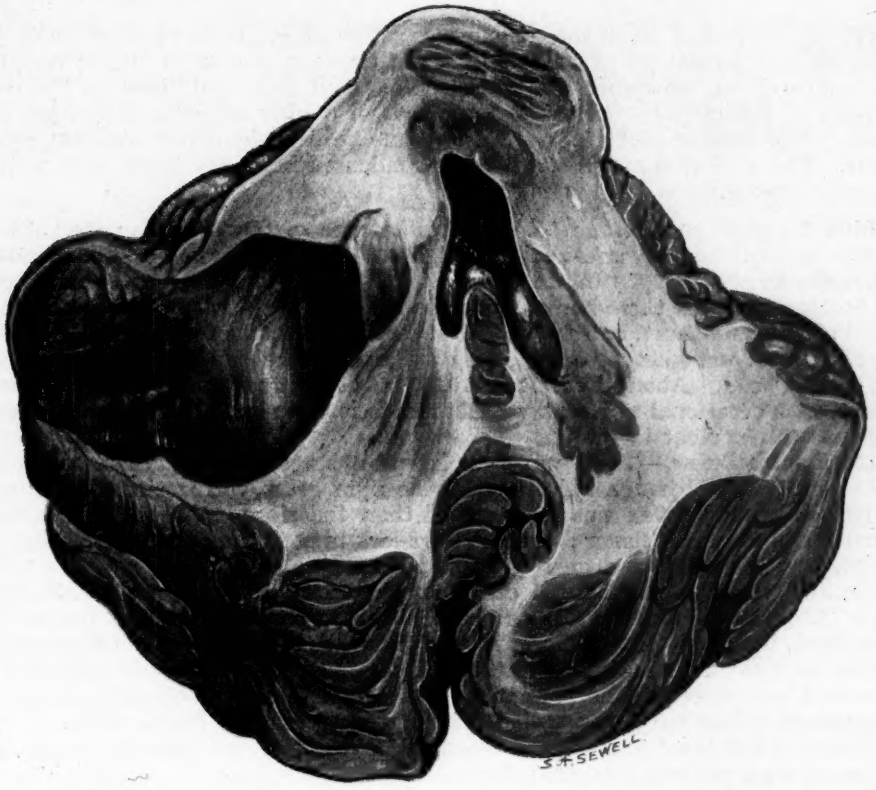

FIG. 72.—*Case* 5. Horizontal section of cerebellum and pons viewed from above.

FIG. 73.—*Case* 5. Section showing numerous foamy cells and a large sinus-like space.

Indeed, the amount of fat in the tumour was astonishing. It was present as droplets of varying size, almost all of which appeared to consist of neutral fat, as very little of the red-staining substance was anisotropic. But here and there in the centre of a mass of red globules, minute dots or rods of doubly refractile substance could be seen. The tumour had a very thin but definite capsule of fine connective-tissue strands. The wall of the cyst consisted of condensed neuroglia fibres, and no lining membrane was present.

Case 6.—J. P., male, age 56. Under the care of Sir Farquhar Buzzard.

This patient was a hard-working, highly intellectual man of good physique, and healthy in every way. In the spring of 1925 he felt very tired and went to Italy for a holiday. Whilst there he was trying to lift a little girl when he lost his balance and fell ; he was not hurt, but shaken. At times after that he found himself unsteady on his legs, but not giddy. Occasionally suffered from sharp shooting pains in the back of the head. About December, 1925, he began to have attacks of morning sickness, with occasional transient partial amaurosis. He had also noticed a tendency to deviate to the right in walking.

On Examination.—There was some lateral nystagmus, rather more to the right than to the left. Although right-handed, the right grasp was weaker than the left. The left abdominal reflex was less marked than the right ; the left plantar reflex indefinite and the right flexor ; the left knee-jerk brisker than the right. The optic discs showed a moderate degree of papillœdema.

On Jan. 23, 1926, a bilateral cerebellar decompression was performed by one of us. A cyst was found in the right hemisphere containing about an ounce of yellow fluid, which clotted readily. It was thought to be a degenerated gliomatous cyst, as no solid tumour was detected. The pressure having been fully relieved, the wound was closed. The patient made a complete and uninterrupted recovery, and returned to his very responsible official work, perfectly fit, in April.

When he left the Nursing Home the optic discs presented a normal appearance, and the nystagmus had disappeared.

He remained quite well until July, 1928, when morning sickness re-commenced, and he felt weak in the limbs. There was no severe headache. When reading he noticed a little blurring of vision.

On Examination.—There was some lateral nystagmus to the right ; no papillœdema, but some engorgement of the veins. The flap bulged a little and was somewhat tense. Aspiration failed to withdraw more than a few drops of fluid. In July a second operation was performed. The flap was turned down, and a small solid tumour, apparently quite definitely circumscribed, was easily removed from within the right cerebellar hemisphere. No trace of a cyst could be detected. The patient recovered even more quickly than after the previous operation, and is now quite well and back at work.

Fig. 74.—*Case* 6. Naked-eye appearances of the tumour, external surface and cross section. (*Actual size.*)

The tumour was a solid reddish mass, oval and somewhat lobulated, but more or less rounded in outline (*Fig.* 74). On its inner surface it appeared to be covered by a thin capsule, while on its outer surface there was a thin layer of cerebellar cortex, which could be separated from the tumour without much difficulty. The tumour measured 3·5 × 2 × 1·8 cm. and weighed 5 grm. On section the cut surface was of a deeper pink colour than the capsule. It looked fleshy and vascular, with several large spaces or channels opening on it, but no blood escaped from these on pressure, nor was coagulated blood visible in them.

Histologically it was very similar to the other angeiomas, especially to that in *Case* 3, in that it contained many very large endothelial cells with irregular nuclei

which seemed to be undergoing degeneration. When stained with Scharlach R. localized accumulation of fatty globules was seen filling one, two, or more neighbouring cells. The rest of the tissue was almost free from fat, but in many of the cells two or three minute fatty granules could be seen with the higher powers of the microscope. The lipoid in the larger collections was much more diffusely anisotropic than in the other tumours examined in this way.

Case 7.—Henry R., age 41, was admitted under Dr. Riddoch to the National Hospital, Queen Square, on March 27, 1925. Eighteen months before admission he had ricked his neck when tying his tie, and thereafter he could not lie on his left side in bed without pain in the neck. Six months later he found that stooping forwards caused severe pain in the back of the head and neck, and lying on the right side in bed also brought on this pain. It became more severe during the following six months, and in November, 1924, he complained of a swimming feeling in his head. He commenced to stagger and sometimes fell, usually to the left side or forwards. He also had at this time transient diplopia in the mornings. In January, 1925, he began to vomit, and the headache became so severe that he sometimes screamed with pain. Towards the end of this month he began to be drowsy. In February he had periods of aphonia or hoarseness in which his voice would leave him for an hour or two. The headache and staggering became much worse, and one day he was semi-comatose.

The patient's family history was uneventful. His parents were both alive. He himself was the eldest of ten children, two of whom died in childhood. One brother was killed in the war ; another had had fits since the age of 13, and a sister was subject to headaches. His own health had been good except for influenza in 1918 and a blow on the chest from the shaft of a cart in 1924. He had never been able to raise his left eyebrow since birth.

On Examination.—There was slight swelling of both optic discs, but good vision and no limitation of the fields. Diplopia was present on looking to the left owing to weakness of the left external rectus muscle. There was no nystagmus. Slight weakness of the lower part of the left side of the face was present. There was no inco-ordination of the arms or legs, but his gait was very unsteady and he could not stand steadily with his feet together and his eyes shut. There was no alteration in the deep or superficial reflexes. Apart from a rounded kyphosis in the upper dorsal region, his spine appeared to be normal, but movements of the neck caused pain.

An operation (left-sided subtentorial craniectomy) was performed by one of us on April 17, 1925. On exposure of the cerebellum the left lobe protruded somewhat more than the right, and was more resilient. It was split transversely, and a cyst was found lying near the middle line but not involving the dentate nucleus. It appeared to extend into the right cerebellar hemisphere, and towards the surface of the cerebellum on its left side. It was tapped, and about 2 oz. of yellowish fluid was removed. No evidence of a tumour was seen at this operation. The patient made an uneventful recovery and left the hospital on May 8, 1925. He improved steadily for over a year, and then began to have headaches, dysarthria, and unsteadiness in walking.

The cyst was again tapped in November and December, 1926. In January, 1927, he had more severe headaches and felt sick in the morning. His gait became unsteady and he had occasional diplopia and dysarthria.

The cyst was tapped for the fourth time in April, 1927, and some clear yellow fluid removed which contained about 4 per cent of protein and 2 cells per c.mm.

In November, 1927, some more fluid identical with that obtained at the previous operation was removed. Two further tappings were done during 1928. After each tapping the symptoms were immediately relieved ; but after varying intervals of time they gradually recurred, and further operative measures were decided upon.

In January, 1929, the patient was suffering from severe headaches and vomiting, and the hernia cerebelli was very prominent and tense. There was marked dysarthria, with hypotonia of the left limbs. He walked fairly well, but tended to

fall to the left. There was a moderate degree of papillœdema. Very slight nystagmus could be detected on extreme lateral deviation of the eyes.

The second operation was performed on Jan. 11, 1929, when a solid tumour was easily removed from the interior of the thinned out, semi-translucent left cerebellar hemisphere (*Fig.* 75). No cyst wall was seen. The most superficial part of the tumour was close to the back of the petrous bone, but not so far forward as the internal auditory meatus. Recovery was rapid and uneventful, and the patient left the hospital at the end of three weeks, greatly improved in every way, and with no cerebellar bulge.

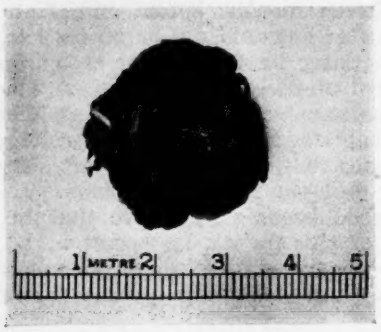

FIG. 75.—*Case* 7. Tumour removed. (*Slightly less than natural size.*)

The tumour was more or less oval, but very lobulated and irregular on the surface. It was reddish yellow in colour. Its outer surface was smooth and glistening, and where it was attached to shreds of cerebellar tissue it was quite delimited from these. There was, however, no definite tumour capsule. It weighed 6·5 grm. and measured 2·5 × 2 × 2 cm. On cross-section it resembled a sponge, as it contained smooth-walled cavities of all sizes, ranging from those scarcely visible to the naked eye to those with a diameter of several millimetres. Some of the latter were obviously dilated blood-channels, but others were empty. The cut surface appeared rather more yellow in the more compact parts than the outer surface of the tumour.

Histologically it was a typical plexiform angeioma with very numerous, interlacing blood-channels of all sizes, from capillaries to fair-sized arteries and veins and sinus-like spaces. The capillaries and sinuses were supported by a very thin connective-tissue layer. Between these blood-channels there were numerous foamy cells, apparently of endothelial nature. With Scharlach R. the majority of these cells were found to be filled with lipoid globules, some apparently being fat and others doubly refractile cholesterin compounds including many myelin crosses. These foamy cells in some parts of the tumour were very numerous, and here and there formed aggregated masses. In other parts little could be seen except blood-channels; but the general structure of the tumour did not vary greatly from one part to another. Near one edge an included area of cerebellar tissue was present. This tumour contained considerably more lipoid than most of the others, and the amount of myelin and other doubly refractile lipoid was especially large.

The following case is added as the tumour was of the same nature, but it appeared to grow from the dorsal surface of the medulla, and it was not associated with a cerebellar cyst.

Case 8.—Elsie R., age 20, was admitted to the National Hospital, Queen Square, under Dr. Riddoch, on Jan. 4, 1929. She had suffered from morning headaches for four years. At first she had frequently vomited with the headache, but recently had not been so much troubled with this. In July, 1926, the headaches became again so severe that she had to give up work. About the beginning of 1928 she began to feel giddy in the mornings, and in September she began to have occasional 'fainting spells'.

During the past year she had had attacks of a tingling sensation in the left arm extending up to the left side of the face. Occasionally she had felt this sensation in both sides of the face. It tended to come on when she was tired. She had also become unsteady and weak in her legs. Since July she had usually felt ill in the morning, but improved later in the day. In December, 1928, her vision became blurred. This was at first transient, but recently had become constant. Her father and mother and her only brother were alive and well.

On Examination.—The patient was an intelligent girl but rather slow-witted. She lay in bed with her head turned to the right and raised on a pillow, and said that any other position of the head brought on a feeling of dizziness. Her vision was very poor; with the right eye she could only distinguish light from darkness; with the left eye her vision was 3/50. Papillœdema was present in both eyes, with 5 dioptres of swelling and some retinal hæmorrhages in the right eye. The right pupil was rather larger than the left, and the right external rectus muscle was paralysed, causing strabismus on looking to the right. There was no nystagmus.

There was some general weakness, hypotonia, and inco-ordination in both arms and legs. All the deep reflexes, with the exception of the biceps-jerks, were absent. The superficial reflexes were present, the plantars being of the normal flexor character. In walking and standing she held her head bent forward and to the right, and the right shoulder a little lower than the left. Her gait was unsteady and ataxic, and she tended to fall to the right. She died shortly after a cerebellar craniotomy by one of us.

Fig. 76.—*Case* 8. Sections across medulla and cerebellum viewed from below and showing tumour *in situ*.

Autopsy.—A post-mortem, limited to the head, was made sixteen hours after death. There was a pressure cone of moderate size in the foramen magnum, and between the lips of the tonsils which formed this cone a reddish vascular tumour, resembling choroid plexus, could be seen protruding in the region of the foramen of Magendie. The whole medulla was swollen and very soft, and the olivary eminences were unduly prominent. Large veins ran from the medulla towards the base of the skull; one of these which ran over the posterior surface of the cerebellum had been ligatured. The arteries were of normal size and were otherwise healthy.

On section across the medulla in the horizontal plane it was found that all the lower half of the fourth ventricle, below the inferior limit of the pons, was filled by a pinkish-yellow, sponge-like mass of tumour which was attached to the floor of the ventricle throughout its extent, but was not attached to the cerebellum where it formed the roof of the ventricle. The choroid plexus was pushed back and flattened between the tumour and the roof of the ventricle. The left foramen of Luschka was widely patent, but the right foramen was closed by adhesions round the tumour. The tumour passed out of the foramen of Magendie for a short distance. Except in so far as its shape was determined by the pressure of the ventricular walls the tumour was rounded and well defined. All over the cut surface there were large sinus-like spaces, and three large veins were seen, one at either lateral margin and one at its posterior extremity. Close to the latter was a hæmorrhagic area, probably resulting from operative trauma.

The tumour measured 2·5 cm. transversely and 3 cm. in antero-posterior diameter. It extended for about 2·5 cm. in a vertical direction. (*Fig.* 76.) The swelling of the medulla was found to be due to œdema. A small cyst had formed in the region of the right cerebellar peduncle close to the tumour, but not touching it. Apart from a considerable degree of hydrocephalus the brain was normal.

Histologically the tumour resembled the others of this series in being composed of a tangled mass of capillary vessels with numerous large endothelial cells, some of which appeared to lie within the lumen of the capillaries and some between them. The capillaries were fairly well supported with fine connective-tissue septa. Many of the endothelial cells were swollen and foamy in appearance, and with Scharlach R. staining were seen to be full of fat granules, but the number of such cells was not so great as in some of the other tumours, nor was any of the lipoid doubly refractile. Numerous larger blood-vessels of all sizes, with fairly well-formed coats of connective tissue were present. In a few of the largest of these there was also a thin muscular coat. Very thin-walled blood sinuses of fairly small size were also seen. There was evidence of neuroglial hyperplasia and some overgrowth of fibrous tissue in the layers of the medulla touching the tumour. Elsewhere the medulla was very œdematous, but otherwise healthy.

DISCUSSION.

These cases, although few in number, are very representative of those in the literature. Although more than one cyst and one tumour is rare, we have had one case of bilateral angeiomatous cysts, and one of multiple tumours, two of which were related to cysts. The bilateral cysts were at first mistaken for simple cysts, until at a later examination a minute tumour was found in relation to each of them. Our series also includes as small and as large tumours of this kind as are usually found.

CHARACTERS OF THE TUMOURS.

The appearance of the tumours is typical and characteristic. They are rounded, and sharply demarcated from the cerebellar tissue. In colour they are pinkish or often somewhat yellow, apparently from the accumulation in many of the cells of a yellowish fatty substance, or possibly from the presence in the cells of altered blood. Small cavities, some of them obviously blood-vessels, are often visible to the naked eye on cut section, but in others the tumour has a more uniform appearance. In colour and consistence they are always quite definitely demarcated from the white matter, although it is not always so easy to make out the line of junction with the cerebellar cortex. In position they affect most frequently the posterior wall of the cysts, and lie either touching, or embedded in, the cerebellar cortex. Many writers, from Hughlings Jackson onwards, refer to their contiguity to the pia mater. In our experience, and in that of Lindau, they always touch the grey matter.

In size they vary from 2 mm. to 2 cm., rarely more. Our specimen (*Case* 6) removed at operation is as large as any that has been seen. Most writers refer to them as of the size of a pea, a bean, a cherry-stone, or an almond. This size bears no relation to the size of the cyst, and large tumours may be related to small cysts (*Case* 1) or large cysts to minute tumours (*Case* 4).

In microscopic characters they agree exactly with Ewing's[6] description of plexiform angeiomas. In some the vascular nature of the tumour is obvious, as it is formed of a mass of capillary vessels lined with endothelium, running

in a groundwork of collagenous fibrous tissue. In such tumours there are, in addition, larger vessels, the majority of which are sinus-like with thin walls. But even in these tumours, which represent the simplest form of angeioma, the endothelial cells lining the capillaries tend to swell and, breaking away from the connective-tissue substratum, lie free in the lumen of the capillary. Some of the capillaries are filled, and apparently blocked, by cells of this kind, and contain no blood. In addition there is a tendency for the endothelial cells to proliferate in the stroma of the tumour, and here they may form fairly large multinucleated cells, or may accumulate lipoid in their cytoplasm, becoming vacuolated in appearance. Lindau emphasizes this peculiarity as distinguishing the cerebellar angeiomas from those found elsewhere in the body. When stained with Sudan or Scharlach a large number of the cells are found to be filled with fatty granules, some of which are doubly refractile.

Other tumours are much more cellular, and the connective-tissue groundwork is very scanty. These tumours resemble cellular endotheliomas, in which capillary vessels are formed between the tumour cells. Between these extreme types all possible variants are found, and often one part of a tumour will resemble one extreme and another the opposite extreme. But between even the extremes there exists a striking family likeness, and it is impossible for a histologist who has seen one of these tumours to fail to recognize another. It is therefore remarkable that so much diversity of nomenclature exists in the literature.

The character of the cyst wall is important. In the majority of cases it consists simply of sclerosed neuroglial tissue, with overgrowth of fibres and few nuclei. Swollen neuroglia cells are sometimes seen, but there is never any resemblance to gliomatous tissue. Usually there is no lining membrane or epithelial covering, but occasionally a few cells resembling endothelium are seen on the wall. In some cases a definite lining membrane has been described, and one of the cysts in our *Case* 1 was lined by such a membrane in which granules of hæmatoidin and hæmosiderin were found, giving evidence of previous hæmorrhage into the cyst. Usually, however, the wall does not differ in colour from the white matter of the cerebellum. The character of the lining membrane when it is present and the normal character of the neuroglial tissue surrounding the cyst make any attempt to remove the cyst wall unnecessary.

It is remarkable with what constancy the dentate nucleus is spared. It is often pushed aside and may be flattened by the pressure inside the cyst, but neither in our cases nor in those previously described is it ever either destroyed or broken into by the enlargement of the cyst. This is all the more remarkable if we consider the size of the cysts and the way in which they thin out the cerebellar cortex ; but it is an encouraging fact to bear in mind, as the experience of the war showed that complete clinical recovery might follow lesions of the cerebellar hemispheres if the dentate nucleus was intact (Holmes[7]). Ernest Sachs[8] relates how one of his patients, one month after the removal of the tumour from the wall of a cerebellar cyst, went for a three-mile walk. In this case the cyst had on several occasions been emptied, either by open operation or by puncture, with only temporary relief. When seen three years after the last operation the patient was still perfectly well.

MODE OF GROWTH OF THE TUMOURS AND CYSTS.

According to Ewing and most other authorities, capillary angeiomas are of congenital origin. It seems likely, however, that they may grow at the expense of the tissues round them. The appearance of the edge of the tumour in our cases suggests a continued outgrowth into the cerebellum. In our *Cases* 6 and 7 it is unlikely that the tumour would have been overlooked at the first operation if it had been as large then as when it was removed. If growth does take place at the expense of the cerebellar tissue, this would explain the amount of fat seen in the larger endothelial cells of the tumours. The character of the fatty inclusions, especially the presence of anisotropic particles in the fat globules, agrees well with its possible origin from broken-down myelin.

The symptoms in most cases, however, appear to be due rather to the increase in the size of the cysts than in that of the tumours. Two possible origins have been suggested for the cysts: (1) That they are formed by the degeneration and liquefaction of the tumours; and (2) That they are caused by the seeping of plasma from the vascular tumours. We can say quite definitely that, at any rate in so far as angeiomatous cysts are concerned, they do not arise in the first manner. The rounded shape of the tumours, and the complete absence of any tumour tissue from other parts of the cyst wall, completely negative this possibility. Gliomatous cysts may arise to some extent from the degeneration of the tumours; but where the tumour is minute and the cyst large, as in Williamson's[9] first case, the theory which he put forward in 1892, that all except a small knot of tumour had degenerated, appears to us in the light of our present knowledge quite untenable.

The second suggestion as to their origin seems much more reasonable. We cannot be certain how the formation of the cyst began, but the history of trauma given by two of our patients, as also by the patient of Cushing and Bailey, and by both the brothers whose cases Seidel[10] reported, is very suggestive. In our two oldest patients, as in Seidel's patient, symptoms of intracranial pressure came on about six months after a fall which was not severe enough to cause any very bad immediate symptoms. In Cushing and Bailey's case the evidence of hæmorrhage from the angeioma at the time of the injury was more direct, as neck rigidity and occipital headache came on at once, and lumbar puncture gave a blood-stained fluid; symptoms of intracranial pressure were, however, deferred for three years. In our second case symptoms referable to the cerebellar cyst came on four years after a wound by a bullet which passed through the face from side to side and must have jarred the skull. The evidence of direct etiological connection between the injury and the cyst formation is therefore in this case slender enough, although it is fairly definite in the older cases. Traumatic cysts are known to occur in the cerebellum as well as in the cerebral hemispheres, and when a small angeioma is already present probably no great degree of trauma is needed to cause slight hæmorrhage or œdema round it. Once the formation of a cyst has begun, it is likely to increase in size as the vascular tumour in its wall exudes plasma into it. The character of the cyst wall suggests that the increase in size is slow, as the neuroglial cells and fibres are usually of an adult type,

and there is no evidence of recent tearing or disintegration of the tissues round the cyst. In fact, the cyst walls are always smooth, and one is surprised to find that they are not lined by an endothelial layer.

FAMILIAL INCIDENCE.

Our first patient gave a history that a brother and a sister had ' died of the same thing '. It was impossible, owing to the war conditions which then obtained, to confirm this history, and of itself it would be of little value. On reviewing the literature we find, however, that a familial incidence of this affection is not very uncommon. Reference has already been made to Seidel's case. The patient's brother who, like himself, was a tight-rope dancer, had shown signs of cerebellar tumour soon after a fall from his rope ; he had been operated on and a cerebellar cyst found. Seidel's patient had, in addition to a cerebellar cyst, a hæmangeioma of the retina. In the case reported by Cushing and Bailey, in which a retinal angeioma was present in addition to the cerebellar growth, the patient's father and paternal aunt had both died from ' cystic sarcomas of the brain '. Lindau recorded, in 1927, a further case of angeioma of the retina with cystic hæmangeioma of the cerebellum, cystic kidneys and pancreas, and hypernephromata in the kidneys and epididymis. The patient's brother had died from what was presumed to be a cerebellar tumour.

No doubt careful inquiry would reveal other familial cases. It is not indeed remarkable that a disease which, like this, is based on a congenital maldevelopment dating back, as Lindau considers, to the third month of fœtal life, should show a tendency to affect more than one member of a family. The fact of familial incidence is, however, of great clinical value, as a history of this kind in a case of intracerebellar tumour would be strong presumptive evidence that we were dealing with a cystic hæmangeioma. Familial cases of eighth-nerve tumour are known, but are very rare ; and gliomatous tumours practically never affect more than one member of a family.

The presumptive evidence given by a family history of cerebellar tumour is, however, much less definite and certain than the presence of a retinal hæmangeioma in the patient himself. This in a case with cerebellar symptoms is practically pathognomonic of hæmangeiomatous cyst of the cerebellum, although the tumour might lie in some closely related part of the brain-stem, such as the pons or medulla. Cushing and Bailey have found in their very numerous records no case of hæmangeiomatous cyst above the tentorium, nor in fact elsewhere than in the cerebellum. But similar tumours have been found in the brain-stem and cord by other observers, and in the latter situation have sometimes been related to cysts.

DISTINCTION OF ANGEIOMATOUS CYSTS FROM GLIOMATOUS CYSTS.

It is not always easy to tell from a naked-eye examination whether a cyst is due to an angeioma or to a glioma, as some gliomatous cysts resemble very closely those we have been describing. Many, however, are easily distinguished by their irregular or multilocular shape, by the presence of trabeculæ passing

from one wall to another, and by the obvious presence of tumour tissue in more than one part of their walls. Angeiomatous cysts are so constantly rounded and smooth-walled that any departure from this appearance should suggest the presence of a glioma.

It is usually not difficult to distinguish an angeioma from a glioma when a knot of tumour tissue is found in the wall. The reddish-yellow colour of the cut surface of the angeioma, its clearly-defined rounded outline, and the presence in it of multiple minute cavities distinguish it fairly readily from a gliomatous nodule, which, apart from obvious hæmorrhages, is usually whiter and smoother, and merges more gradually into the surrounding brain tissue.

The apparent presence of a lining membrane is of equivocal value as a distinguishing mark. Such an appearance is usually merely the result of hæmorrhage into the cyst which has stained the inner layers of the walls, a condition which may be found in either form. As we have seen, removal of such a lining membrane is as unnecessary in the case of an angeiomatous cyst as it is likely to be ineffectual in the case of a gliomatous cyst.

THE QUESTION OF SIMPLE CYSTS OF THE CEREBELLUM.

Lindau records two cases of what appear to be simple cysts of the cerebellum. Both were museum specimens, and in neither was the wall of the cyst complete, so that it is possible that a small tumour existed in the part of the wall which had been removed. In one of the cases the cyst resembled an angeiomatous cyst in lying in one cerebellar hemisphere and in pushing the dentate nucleus aside without destroying it. In the other case the cyst lay in the mid-line under the vermis, which is an unusual situation for an angeiomatous cyst. The possibility of a minute tumour causing a large cyst, as in our *Case* 4, and in a case recorded by Williamson, makes us doubtful about the existence of simple developmental cysts of the cerebellum. One of the tumours in our *Case* 4 was so small and—lying in a dimple in the wall of the cyst—was so hidden from sight that it was at first overlooked. In one of Williamson's cases the tumour was very minute, measuring only 2·5 × 4 mm., in a cyst the size of a pigeon's egg. Certainly it is the duty of the surgeon, when he encounters a cyst in the cerebellar hemisphere, to search carefully for the tumour, or if it is not apparent, to remove the tissue round any dimple that may be seen projecting into the cerebellar cortex. Our *Cases* 6 and 7, and the case of Sachs which we have quoted, suggest that by doing so the patient may be saved from a recurrence of symptoms and a second operation.

CONCLUSIONS.

1. The majority of cerebellar cysts have capillary hæmangeiomas in their walls. These angeiomas are always embedded in the cortex of the cerebellum, and frequently lie in a small dimple in the wall of the cyst.

2. Angeiomatous cysts of the cerebellum frequently co-exist with retinal angeiomas, hypernephromas, or cystic disease of the kidneys or pancreas.

3. Cerebellar cysts of this kind may have a familial incidence, occurring in members either of the same or of successive generations.

4. A close relationship to a trauma of the head or a severe fall has been established in several cases. It is probable that the trauma may start the formation of a cyst in a patient who already has an angeioma of the cerebellum.

5. Angeiomatous cysts have no lining membrane. Their walls are formed by a condensation of the normal neuroglia.

6. Simple emptying of such a cyst rarely brings about a permanent cure. Removal of the tumour from the wall of the cyst seems, however, to prevent the recurrence of symptoms.

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SPECIAL ARTICLES ON SURGICAL TECHNIQUE.

SURGICAL TECHNIQUE OF PULMONARY ABSCESS.

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Abscess in the lung arises from a localized infection which may result from : (1) a preceding attack of either lobar pneumonia or bronchopneumonia, (2) an infected embolus, or (3) inhalation of infected material. The last two causes are more common precursors than pneumonia, and in the large majority of cases the pulmonary infection has succeeded some general operation or one upon some portion of the respiratory tract. Experimentally, it has been possible with certain precautions to produce abscesses of both embolic and inhalation types. Multiple foci resulting from these causes eventuate in a condition of diffuse septic pneumonia, and when the infection is localized but of great virulence, or the individual resistance low, the condition of gangrene supervenes.

Those abscesses arising as a result of pneumonia or of embolus are very similar in character, both as regards their clinical manifestations and the radiographic appearances. When they are single, and the patient has not been too exhausted by the previous illness, the prognosis with regard to eventual cure is reasonably good if they are adequately treated at the right time. Those in which inhalation of septic material has been the primary cause, on the other hand, rarely recover as completely as the former class. It would appear that this is due to delayed diagnosis, the condition being confused with bronchiectasis, purulent bronchitis, and sometimes called unresolved pneumonia. With more modern methods of diagnosis and the more general adoption of X-ray examination in doubtful chest diseases these diagnostic errors should become less frequent.

This is not the occasion to discuss the general signs and symptoms of pulmonary abscess, but in order to carry out the surgical treatment efficiently it is essential that very careful localization of the abscess should be ensured before operation. X-ray examination of the chest in these circumstances is essential. Skiagrams should be taken in the antero-posterior, lateral, and oblique positions, and in certain cases stereoscopic views may afford useful information. Abscesses following the lodgement of an embolus and pneumonia are generally similar in their radiographic appearance. In the early stages and before leakage into a bronchus has occurred, the abscess appears as a

somewhat diffuse homogeneous shadow in the clear lung area, generally inclined to be roughly circular or oval in outline (*Fig.* 77). Following rupture into a bronchus it is common to see a definite line of fluid level with a clearer area of air above, which fluid level changes with alteration in the position of the patient. This type might be termed 'the simple chronic abscess' (*Fig.* 78). In abscess following inhalation of infected material, the area of shadow is commonly more extensive and diffuse. Leakage into the bronchus occurs early, but it is uncommon to see any fluid level or to be able to distinguish the presence of air in the abscess by radiographic methods. This variety is termed 'the bronchiectatic abscess', and arises primarily in the bronchioles.

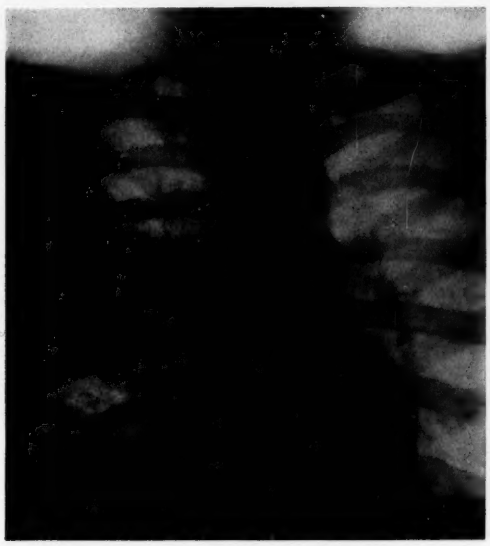

FIG. 77.—Simple chronic abscess of lung before rupture into bronchus.

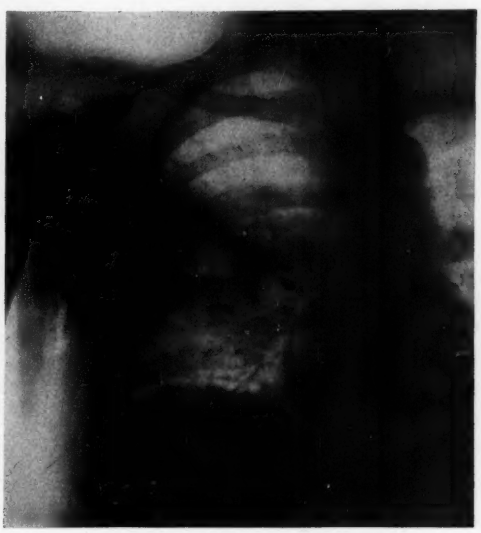

FIG. 78.—Same case as *Fig.* 77 after rupture into bronchus. Note fluid level with air in upper part.

Further confirmation can be obtained by the introduction of lipiodol into the bronchial tree. In the simple chronic abscess the thick oily solution is unable to enter the abscess cavity owing to the congestion and œdema of the mucosa of the communicating bronchus. A similar condition is often present in one of the larger bronchi in cases of bronchiectatic abscess, and the sudden arrest of the lipiodol in one of the secondary bronchi can be clearly seen. Spreading out in a more or less triangular area, from the blocked bronchus as an apex, is the shadow of the abscess, this area being completely devoid of lipiodol—the 'silent area' (*Figs.* 79, 80). In bronchiectasis the dilatation of the tubes is clearly shown.

TREATMENT.

A certain proportion of abscesses in the lung clear up entirely without operative treatment. Under these circumstances all patients should be given the benefit of measures which will induce drainage through normal channels —the bronchi. All possible infective foci in the upper air-passages—teeth,

sinuses, tonsils—should be carefully examined, and if any source of infection is found measures for its elimination should be instituted. Natural drainage is encouraged by placing the patient in such a position as will most easily empty the abscess cavity into the main bronchial tubes—postural drainage. This position will vary with the site of the abscess, and to a certain extent in different individuals. When the optimum position is found it should be occupied for gradually increasing periods at least twice a day. The constant presence of spirochætes in the pus from almost all types of pulmonary abscess suggests the administration of one or other of the arsenical preparations. Intravenous administration of novarsenobenzol, in small doses at intervals of five to seven days, is of advantage. Should the abscess show definite signs of healing both from the clinical and—more important — from the radiographic examination, operative interference should be withheld; but if in spite of the above measures there is no improvement, or even deterioration, surgical drainage should be instituted.

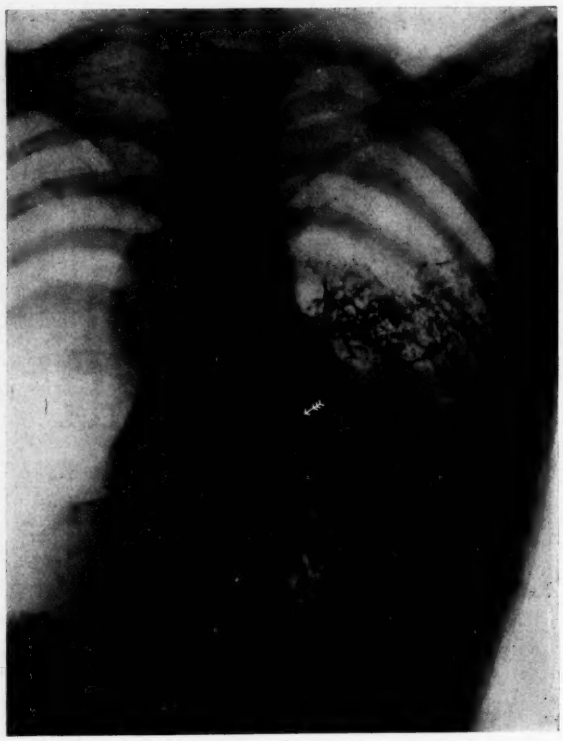

FIG. 79. — Bronchiectatic abscess (inhalation). Unfilled area between two normally filled areas. Small blocked bronchus shown by arrow.

Pre-operative Treatment.—No effort should be spared in getting the patient into as fit a state as possible before operation, and in certain cases this will require such measures as transfusion of blood; rectal administration of fluids with glucose, cardiac stimulants, and the judicious use of hypnotics for the induction of sleep for a day or two before operation are all of value. On the day of operation every effort is made to induce the patient to evacuate, by posture, the fluid contents of the abscess cavity.

Anæsthesia.—Local anæsthesia is the method of choice in these cases. It may be preceded by an injection of morphia, $\frac{1}{6}$ gr., atropine $\frac{1}{150}$ gr., hyoscine $\frac{1}{150}$ gr., injected half an hour before operation. Paravertebral anæsthesia is quite unnecessary, and local infiltration with anæsthetization of the intercostal nerves involved is invariably sufficient.

When general anæsthesia is used some form of positive-pressure administration should be adopted, and gas and oxygen is the anæsthetic of choice. By inducing positive pressure, when the abscess is opened aspiration into and flooding of the bronchial tree by the purulent contents is prevented.

Operation.—Abscesses arising in the upper lobes are best approached through an upper axillary incision, of the middle right lobe through an anterior incision, and of the lower lobes through posterior incisions, the exact position depending upon the site of the abscess. That point on the chest wall nearest to the abscess is chosen in order as far as possible to avoid interference with and damage to normal lung during the operation.

Operation in One Stage.—A vertical incision of from three to four inches in length is made through the superficial tissues of the chest wall, exposing the ribs and intercostal structures. A rib overlying the abscess is resected subperiosteally, and the subjacent periosteum and pleura are examined. The presence of œdema and a sensation of firmness is good evidence of adhesions between the pleural layers. An aspirating needle is now inserted into the subjacent adherent lung and an attempt made to enter the abscess. The presence of the point of the needle within the abscess cavity is shown by the aspiration of pus or of foul-smelling gas.

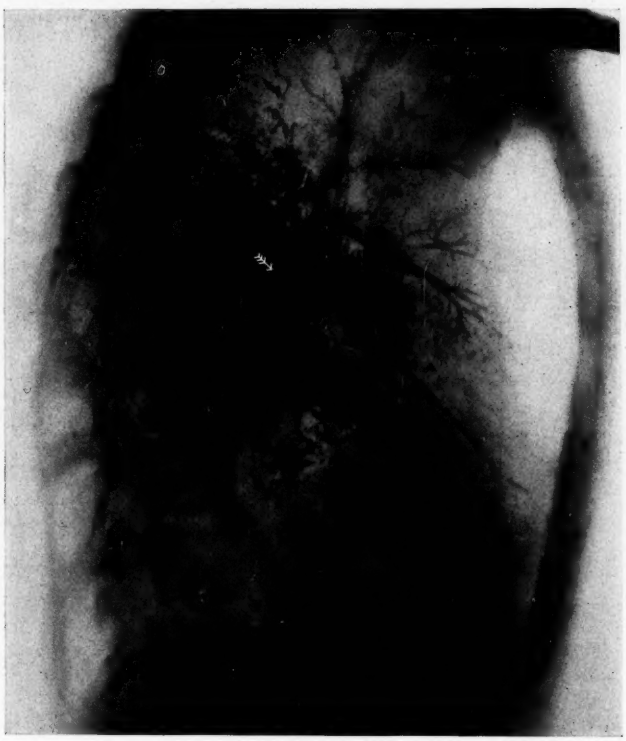

Fig. 80.—Same case as *Fig.* 79, lateral view. Note 'silent area' with small blocked bronchus near hilum, indicated by arrow.

When the abscess is somewhat deep-seated it is advisable to leave the needle *in situ* and to incise the lung alongside the needle until the abscess cavity is exposed. The small track may be enlarged with forceps to allow adequate exposure, but it is better practice to use a cautery at a dull red heat, as vessels with their walls held wide open by the rigid inflamed tissue will be sealed by the cautery and embolism thereby avoided. The contents of the abscess, pus or inspissated mucopus, are carefully removed. Hæmorrhage from the walls of the cavity is rarely serious and can be controlled by light packing with dry gauze for a short while, or with gauze which has been soaked in coagulen and squeezed almost dry. Care should be taken not to allow the gauze to enter the bronchus, as it will result in excessive coughing attacks.

Drainage should be carried out by means of a soft-walled drainage tube, but it is necessary, when there is a considerable area of induration around a large abscess, to remove a portion of the rib above or below (whichever is

better in the individual case) with the intercostal structures between the resected ribs, to permit retraction of the pulmonary tissue as healing occurs. In the majority of cases close suture of the chest wall around the tube is to be avoided, and, to prevent a spreading cellulitis, the wound should be left open and lightly packed with gauze.

In the bronchiectatic abscess the bronchial fistulæ show themselves by respiratory sounds at the time of operation, but in the simple chronic abscess communication between the bronchus and the abscess cavity will not be free for two or three days—i.e., until the œdema of the mucosa has disappeared.

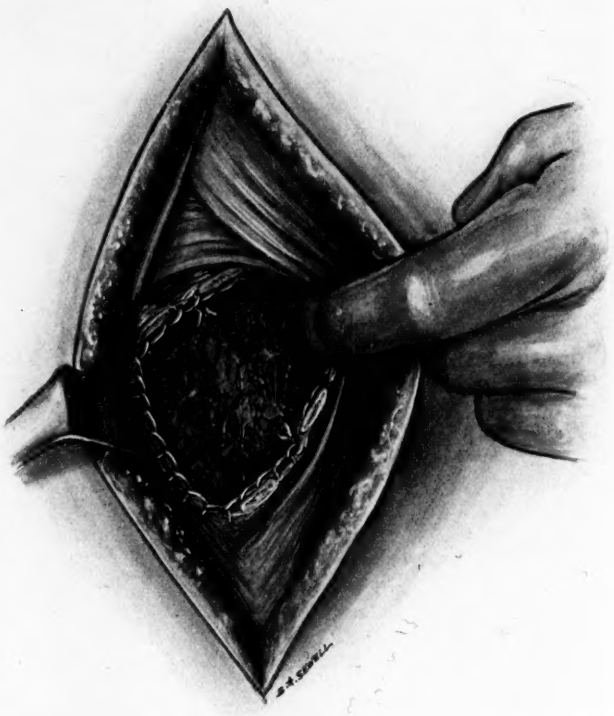

FIG. 81.—*Stage I* of two-stage operation. In this case the pleura has been opened and the indurated area brought to the surface and sutured. (Inhalation abscess.)

OPERATION IN TWO STAGES.—Where, after resection of a rib, adhesions between the pleural layers are absent—in some cases the lung can be seen moving freely beneath the parietal layer—it is inadvisable to open the abscess in one stage. A portion of the adjacent rib is resected and the intercostal structures between the resected ribs are separated from the parietal pleura and removed.

Careful palpation of the subjacent lung through the intact parietal pleura may disclose evidence of induration. Should this be the case, a pack of iodoform gauze is laid against the parietal pleura and the superficial parts of the wound are loosely closed over it. Firm pleural adhesions should be present in six or eight days as a result of the irritation caused by the pack.

When no induration can be felt in the lung a small incision is made in the parietal pleura and the finger inserted to palpate the lung. If air is allowed to enter the pleural space slowly there is no shock in this procedure. The indurated portion of the lung is brought up to the opening in the pleura, and by means of an overlapping suture is fixed to the chest wall. This suture should pass through firm tissue—including the periosteum of the resected ribs and the intercostal muscles—around the edges of the wound (*Fig.* 81), not through the parietal pleura alone, which is likely to tear. The whole wound is again lightly packed with iodoform gauze for

several days to allow firm adhesions to form, and the skin is drawn together with a few sutures.

Where previous localization of the abscess has been inexact it may not be possible to bring up the involved area to the operation wound owing to the presence of pleural adhesions overlying the abscess, in which case another incision and rib resection will be required over the adherent area, the original wound being carefully sutured without drainage.

The second-stage opening of the abscess is performed in six to eight days, without anæsthetic of any sort except perhaps the administration of a small dose of morphia. After the removal of the gauze pack the abscess is sought by an aspirating needle, and the cavity opened by a cautery (*Fig.* 82). Drainage is instituted as described above in the one-stage operation.

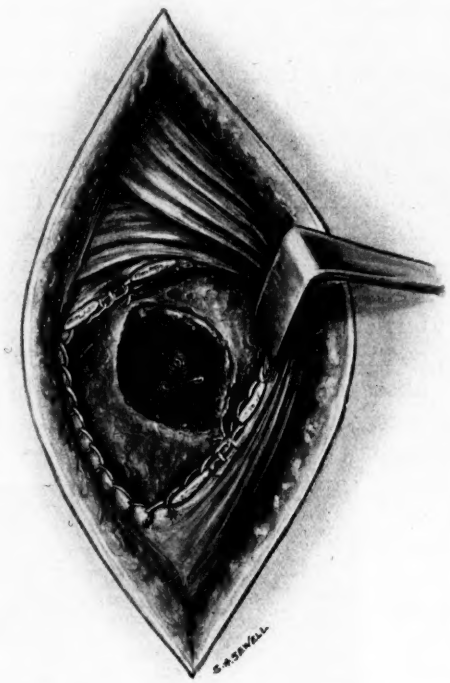

FIG. 82.—*Stage II* of two-stage operation. Firm adhesions are present. The original suture can still be seen. Abscess opened, after aspiration, with cautery. The openings of the bronchi can be seen in the floor of the abscess. (Inhalation abscess.)

After-treatment.—Immediately after operation the patient is returned to bed and placed in a semi-erect position, inclined towards the affected side. Expectoration is aided during coughing by firm manual support over the operative area.

The wound will require frequent change of dressing, and fœtor due to anaerobic infection may be diminished by the passage of oxygen in a slow stream through a fine catheter, introduced either through or at the side of the drainage tube. In order to eradicate the spirochætal infection almost invariably present, arsenic may be administered either into a vein or into the muscles as soon as the immediate post-operation reaction has passed off.

In a well-drained case the sputum steadily diminishes in quantity and becomes less purulent and more mucoid in type, the appearance of the wound and its discharge improving at the same time. Drainage should be maintained until the sputum is negligible in quantity, the abscess cavity obliterated except for the drainage track, and the discharge almost completely serous. In the embolic and post-pneumonic abscesses complete healing may occur in six to eight weeks, but in the abscesses following inhalation healing may be delayed for several months. This is especially the case when diagnosis is delayed, treatment has been instituted at a late stage, and secondary bronchiectasis is already established.

Prevention of Secondary Bronchiectasis.—Abscesses in the lung heal in a precisely similar manner to those elsewhere in the body by the approximation of their walls and their final coalescence. In soft parts elsewhere the destruction of tissue due to infection is balanced by the elasticity of the surrounding tissues, which allows fibrosis to obliterate the cavity by contraction. Conditions in the chest, however, are altered by the comparative rigidity of the chest wall. Larger abscesses in the lung will, following drainage, slowly contract, the surrounding structures—such as chest wall, diaphragm, and mediastinum—giving way to some degree. In a number of cases, and especially in older subjects, this retraction is insufficient to obliterate the cavity. The thin-walled bronchi now commence to be pulled upon by the contracting fibrous tissue around the abscess. Distortion and dilatation of the bronchi result, and are soon succeeded by secondary infection, when the complete picture of bronchiectasis is established.

FIG. 83.—Same case as *Fig.* 77 after drainage, before lipiodol injection.

This process may delay healing of the external wound, or may follow external healing of an incompletely drained abscess. In the former case purulent expectoration and discharge from the wound will persist in spite of adequate drainage; in the latter, expectoration—which had once disappeared—will reappear, become more purulent, and increase. In both cases an attempt should be made to diminish the capacity of the hemithorax and thereby produce relaxation of the lung. Operative measures are preceded by lipiodol injection and X-ray examination to demonstrate the bronchial dilatation (*Figs.* 83, 84).

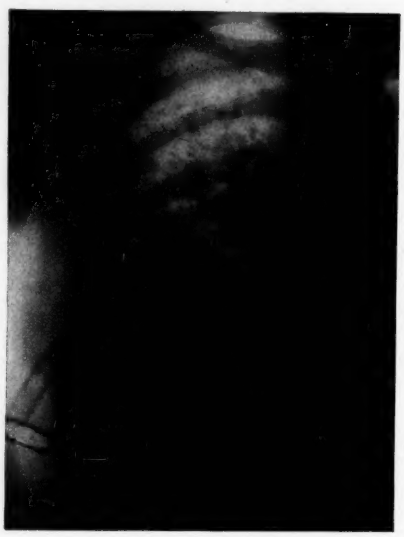

FIG. 84.—Same case as *Fig.* 83 after lipiodol, showing localized bronchiectasis resulting from contraction of abscess. Permanent healing without symptoms followed phrenic avulsion.

In early cases of secondary bronchiectasis, and especially those in which the healing of the external fistula is followed by increase in sputum, phrenic avulsion is often curative, and in all cases should be given a trial before more serious measures are contemplated.

In those in which bronchiectasis is established before the abscess has been opened, phrenic avulsion will need to be followed by prolonged drainage.

FIG. 85.—Generalized bronchiectasis secondary to drainage and external healing of large pulmonary abscess. Condition one year later required complete thoracoplasty.

When bronchiectasis secondary to a healed abscess has become well established and generalized, complete thoracoplasty preceded by phrenic avulsion will be necessary (*Fig.* 85).

DUODENAL ULCERS FOLLOWING BURNS: WITH THE REPORT OF TWO CASES.

By JOSEPH J. LEVIN,

HON. SURGEON TO THE GENERAL HOSPITAL, JOHANNESBURG.

Curling in 1842 first described a duodenal ulcer following a burn, and Sherren in commenting on this in Choyce's *System of Surgery* says, " Ulcers occurring in the duodenum complicating severe burns were described by Curling in 1842 (Fig. 380), and it is said they may also be present in the stomach, and in the intestine lower down. Usually single, they are met with most often in the first portion and begin as hæmorrhagic erosions. They are said to occur, as a rule, from seven to fourteen days after the burn, but they may be discovered earlier—in one case (Parfick) they were seen within eighteen hours. These ulcers often lead to a fatal issue within a few days, from hæmorrhage or perforation. They were most frequently met with by older writers. Thus Fenwick, from the statistics of Holmes, Erichsen, Perry and Shaw, found this complication in 6·2 per cent of all fatal cases of burns. These ulcers are now not often found after burns, and *some authors deny that the two conditions are associated.* Various explanations have been given of the development of the acute ulcers, but they are probably of toxæmic origin, and can thus be brought into line with other acute peptic ulcers."

Similar views seem to be held by most text-book writers, and the position is that the majority of authors are agreed that duodenal ulcers do occur after burns; but one gains the impression that very few present-day surgeons or pathologists have actually seen such ulcers, and there appears to be some divergence of opinion as to the exact portion of the duodenum in which they occur, whether they occur in children or in adults, and whether they are likely to perforate or not.

It would be excusable, therefore, if after many years of a type of practice in which one would expect to meet such cases and did not meet them, one began to doubt whether duodenal ulcers really did occur to-day after burns, and thought that possibly the mere assertion that they did so was one of those statements which have been taken over from one text-book to another without actual verification by the different authors. I say " really did occur to-day " because there would appear to be some justification for thinking that such ulcers did occur more frequently in, say, Curling's time than to-day, for three reasons: (1) Because oil lamps, candles, and gas lamps have to a large extent been superseded by electric light; (2) Because of the more cleanly treatment of burns; and (3) Because of the decrease of drunkenness in later years, especially in the British Isles since the War. (Children of the working classes are possibly better protected by their parents.) The experience of my predecessor as District Surgeon in the Central Area of Johannesburg

(Dr. Heberden), who definitely informed me that, although during the ten years he held the post he had always particularly looked for duodenal ulcers when performing post-mortem examinations in cases of burning and scalding, he could not recollect ever having seen one; the experience of the other two District Surgeons in Johannesburg (Dr. W. Girdwood and Dr. R. Ray), one of whom has held office for over fifteen years and the other for nearly ten years, without having seen such an ulcer after a burn; and my own experience until recently rather tended to support the doubt. I have held the post of District Surgeon for thirteen and a half years and have rarely failed in cases of burning and scalding to look for duodenal ulcers, and until recently I have never seen one. The post-mortem examinations are carried out in the Government Mortuary, where at any rate during the last thirteen and a half years we have averaged between 900 and 1000 examinations per annum. All persons dying from unnatural causes and all deaths from accidents (including all burning and scalding accidents) in the Johannesburg magisterial area (approximately 100 square miles) and for some distance beyond, must come to this mortuary. Our experience, therefore, is not inconsiderable, yet in spite of this mass of suitable material neither my predecessor nor my colleagues in this type of work nor I (until recently) had seen a case.

Now, however, my doubts have been set at rest. A couple of years ago I found a small ulcer in the duodenum of a child who had died from the effects of burns. I have lost the specimen, and my recollection of the case is not very accurate in details, but there is no doubt about three facts in connection with the case: (1) The victim was a child; (2) Death was due to burns; (3) There was a duodenal ulcer. In addition to this case I may say that on one or two occasions I have seen a duodenitis after burns or scalds.

On Aug. 1, 1928, I examined the dead body of a native female child, age 3 years and 11 months, who had died on July 31, as a result of scalds. The child had been accidently scalded on July 21 and was admitted to the Non-European Branch of the General Hospital, Johannesburg, on that day. The hospital notes say that she was suffering markedly from shock on admission. She recovered from the shock, however, in about thirty-six hours, and then the stage of reaction followed by that of toxæmia set in as evidenced by the temperature chart. The temperature varied between 99° and 102° for the following eight days, the pulse from 116 to 140, and respiration from 22 to 44. The child died on the tenth day after admission.

At the post-mortem examination I found that there had been extensive scalds on the front of the neck, left side of the neck, and behind the left ear. There was also extensive scalding of the left arm, the front and left side of the chest and abdomen, left scapular region, left lower limb, left buttock, and right arm. The scalds were septic. The right lung was adherent to the diaphragm by recent adhesions. There were small patches of lymph on the surface of the right lung, and there was evidence of bronchopneumonia in the lung.

On the anterior surface of the first part of the duodenum I found a perforated ulcer (*Fig.* 86) which I demonstrated to half a dozen members of my class of Forensic Medicine who were in the mortuary. Then, before disturbing the parts, I sent for Dr. J. Harvey Pirie, late Senior Pathologist to, and

at present engaged in research work at, the South African Institute for Medical Research, to verify my 'find'. I removed the duodenum and stomach and had the specimen preserved and photographed at the South African Institute for Medical Research, where it has also been seen by three

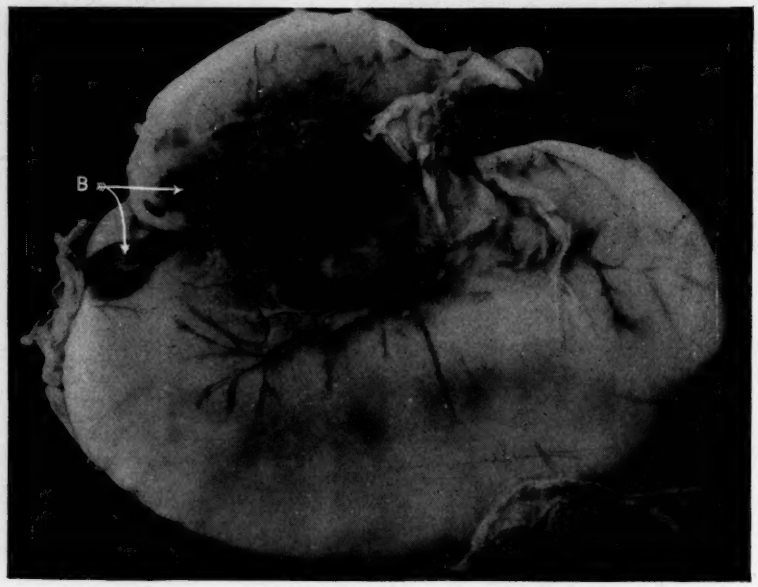

FIG. 86.—Showing perforated ulcer on the anterior surface of the first part of the duodenum. B, Bile staining.

other experienced pathologists. There was no evidence of peritonitis or escape of stomach or intestinal contents. One therefore concluded that the ulcer had perforated shortly before death and the bronchopneumonia following the burns was the cause of death.

PATHOLOGY.

Pathologists are apparently not yet agreed about the exact pathology of duodenal ulcers associated with burns. Some think that they are due to vascular thrombosis, others that they are due to the elimination of toxins from the liver by way of the bile-duct, the toxins being absorbed from the septic burnt or scalded areas. It seems to me, however, that if one accepts as a theory for shock the following sequence of events—trauma resulting in lowered blood-pressure followed by interference with tissue metabolism ending ultimately in an acidosis—a more or less satisfactory pathology for duodenal ulcer associated with burns can be evolved which fits in with the usually accepted theory for the causation of duodenal ulcers generally.

In severe burns four stages develop as a rule: (1) The stage of profound shock (more profound in children); (2) The stage of reaction; (3) The stage of toxæmia; (4) The stage of recovery or death.

As a result of the shock if there is not a *true* hyperacidity one can safely

assume that the alkaline reserve has been seriously depleted and that there exists at any rate a *relative* hyperacidity. Toxins are absorbed into the tissues in cases of burns, first as a result of the production of a peculiar substance, said to be akin to histamine, and secondly as a result of the sepsis in the burnt areas. We have therefore the toxins which devitalize the duodenal mucous membrane causing possibly an erosion, and also the hyperacidity which favours the full development of an ulcer.

The localization is explained, as all duodenal ulcers are explained to-day, by the tortuosity of the vessels of the lesser curvature of the stomach and first part of the duodenum and their relatively poor anastomosis rendering them more liable to thrombosis.

The whole present-day theory of the development of gastric and duodenal ulcers is, to my mind, unsatisfactory, but I suggest that by bearing in mind the ultimate acidosis of shock a theory for the development of duodenal ulcers associated with burns, *especially in children*, can be conveniently fitted in.

CONCLUSIONS.

1. Acute duodenal ulcers are found post mortem in cases of death following burns and scalds, but rarely so.
2. There would seem to be special reasons for their occurring in the first part of the duodenum.
3. These ulcers may perforate.
4. The ulcers do occur in children (Curling's case and the two cases here recorded), and are possibly more likely to do so because of the more profound shock in the young.

THE TREATMENT OF CONGENITAL DEFECTS OF THE BLADDER AND URETHRA BY IMPLANTATION OF THE URETERS INTO THE BOWEL: WITH A RECORD OF 17 PERSONAL CASES.

(Based on a Hunterian Lecture delivered at the Royal College of Surgeons of England, on Feb. 8, 1928.)

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INTRODUCTION.

An early interest in the incontinent bladder has perhaps been the means of attracting these cases to my care, and I hope that a review of the results will stimulate further interest in the treatment of these distressing deformities, and will justify the method which has been employed.

As a dresser in the wards of the old Royal Infirmary at Newcastle-upon-Tyne in the year 1896 and afterwards, I saw much of two cases of ectopia that were being treated painstakingly and laboriously by the plastic measures then in vogue, and I remember vividly the utter futility of the conscientious efforts of that most careful and painstaking surgeon, the late Dr. G. H. Hume. The distress of another patient (*Fig.* 87), whose ardent nature impelled him to seek that sexual gratification which his disability denied him, also made a profound impression on my mind, and I have never lost sight of the importance of the sexual problem in these cases. At that time most surgeons were discontented with these plastic operations, for, at the best, they could only make it possible for the patient to drag out a less miserable existence with the aid of some form of apparatus to catch the urine.

In these cases I think the fortitude of the patients was even more to be admired than the perseverance of the surgeons. One patient, a young man of 20, who subsequently came under my own observation, submitted to nine plastic operations in two years, the final result being depicted in the photograph (*Fig.* 88 *b*), which shows that the maximum result obtained was the protection of the upper part of the exposed bladder by a flap of skin, and that he still has to wear a large and cumbersome apparatus. At night the latter is useless and he lies in a pool of urine. As may well be understood, this patient is a determined Northumbrian, for, at 15 years of age, before any operation was contemplated, he started to work in the pits, and it was only the non-success of the urinal which he then wore that induced him to seek surgical aid. Ever since the last operation he has continued at work, and now at 41 years of age he is regularly employed. He is in good health, and without any evidence of infection or of renal insufficiency. But this case is nothing compared with that of a boy recorded

by Stewart McKay,[1] who between the ages of 4 and 10 endured no fewer than forty-nine such operations until he was finally relieved by the transplantation of the ureters into the bowel.

In those early days I also saw attempts made to establish a permanent opening between the bladder and the rectum, the idea being that the route into the rectum having become stabilized, the sphincter ani would control the escape of urine and the bladder could be completely closed at a later date. Alas! all these methods were unavailing, and both surgeons and patients became inured to disappointment. Further, I was brought up in the belief that the union of the ureters to the bowel was always followed by ascending infection of the kidneys which soon proved fatal, and that position was generally accepted amongst surgeons, and I fear has not quite disappeared even to-day.

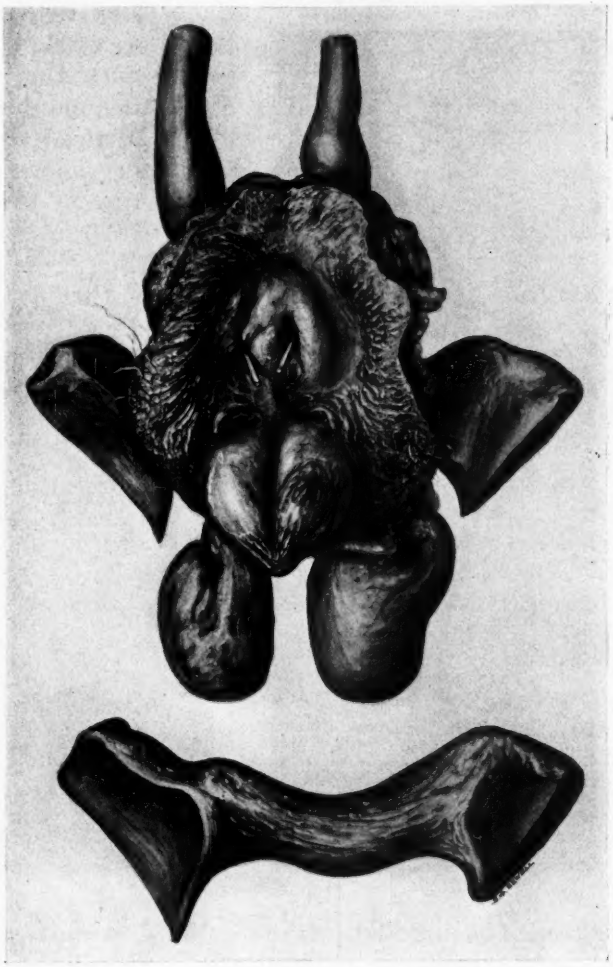
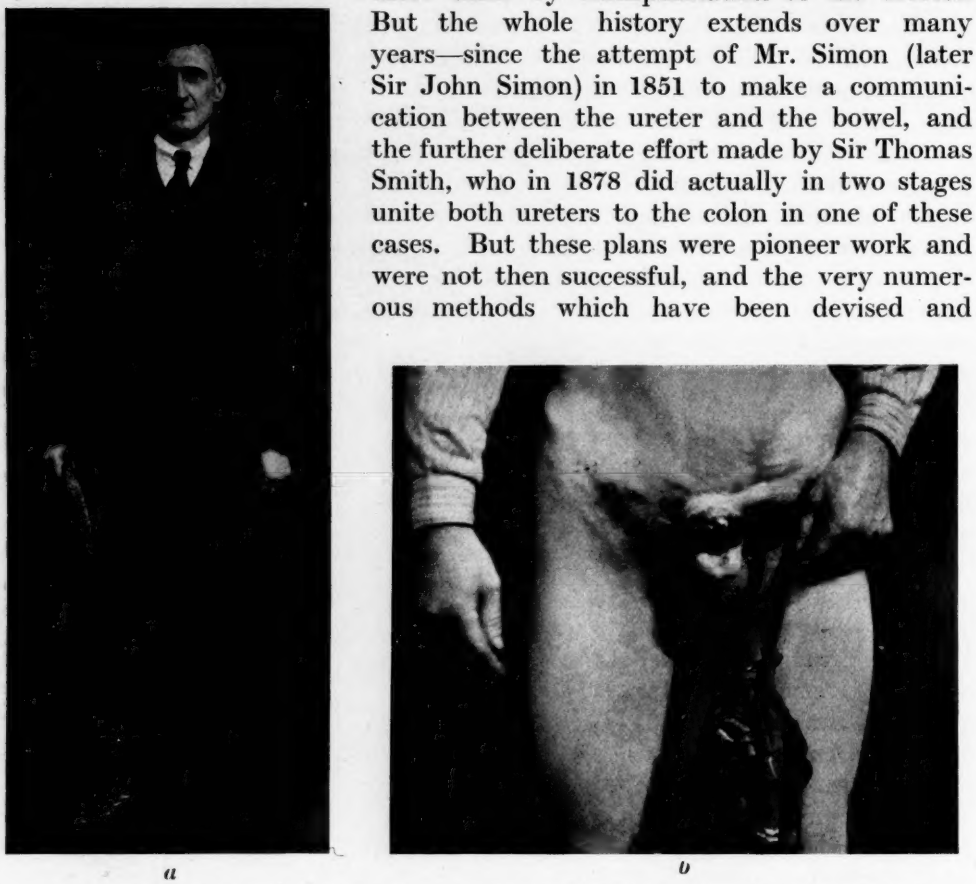


FIG. 87.—The parts from an adult, the subject of complete ectopia vesicæ. Note the dilatation of the ureters and the well-developed testicles; also the wide separation of the pubes, and the very thick and strong interpubic ligament.

In 1911 new interest was aroused in this subject as the result of a paper by Sir Harold Stiles,[2] which he read before the American Surgical Association in Denver City, on "Epispadias in the Female and its Surgical Treatment, with a report of Two Cases". He there described a method which he had devised of implanting the ureters into the sigmoid which aimed at making a valvular opening, by which he hoped to lessen the risk of ascending infection. The cases were both female children, on whom he had operated by this method with good results. Personally I was prepared for the announcement, for in March of the previous year in Edinburgh I had seen the first patient on whom he had carried out his operation. She was then in good health and with perfect rectal function and control. (*See* p. 176 for further history of these patients—*Cases* C. D. and A. McK.)

I was at once arrested by his work, for I conceived that at last there was some hope of relieving the miserable condition of this class of case. Soon after the publication of his paper Sir Harold told me of a visit which these children had made to the theatre, and I was fascinated by the story of these little girls who were able to sit in comfort and enjoyment throughout the whole performance of *Peter Pan.*

Such is the story of my personal introduction to the treatment of these cases by transplantation of the ureters. But the whole history extends over many years—since the attempt of Mr. Simon (later Sir John Simon) in 1851 to make a communication between the ureter and the bowel, and the further deliberate effort made by Sir Thomas Smith, who in 1878 did actually in two stages unite both ureters to the colon in one of these cases. But these plans were pioneer work and were not then successful, and the very numerous methods which have been devised and



a *b*

FIG. 88.—(*a*) A man, 41 years of age, with a persistent ectopia, who works regularly about the mines. (*b*) Twenty years ago, as the result of nine operations, the upper part of the exposed bladder was covered by a flap of skin. This enabled him to wear the cumbersome urinal on which he still depends for keeping him reasonably dry during the day. At night he is continuously wet.

tried during the intervening years unfold a wonderful chapter of persevering ingenuity on the part of innumerable surgeons the world over, and great fortitude on the part of countless sufferers. The mere recital of the names of those who are known to have taken part in the work would make a formidable list, and would not by any means indicate the amount of effort expended, for nameless numbers have contributed their quota and masses of animal experimentation have also been carried out.

Briefly the method of Stiles is an intraperitoneal anastomosis of the

ureters into the recto-sigmoid (*Fig.* 89). The operation is carried out through an abdominal incision. About 1½ inches of the ureter are buried in the bowel wall, much after the fashion of the Witzel gastrostomy. The ureters are anastomosed one at a time, with an interval of two or three weeks or more, depending on the recovery from the first interference. Probably there is always some mild renal infection, but that which occurs after the first operation seems to confer some immunity against the severity of any which may occur after the second ureter is transplanted.

The patients soon learn to retain their urine in the rectum, and, in nearly

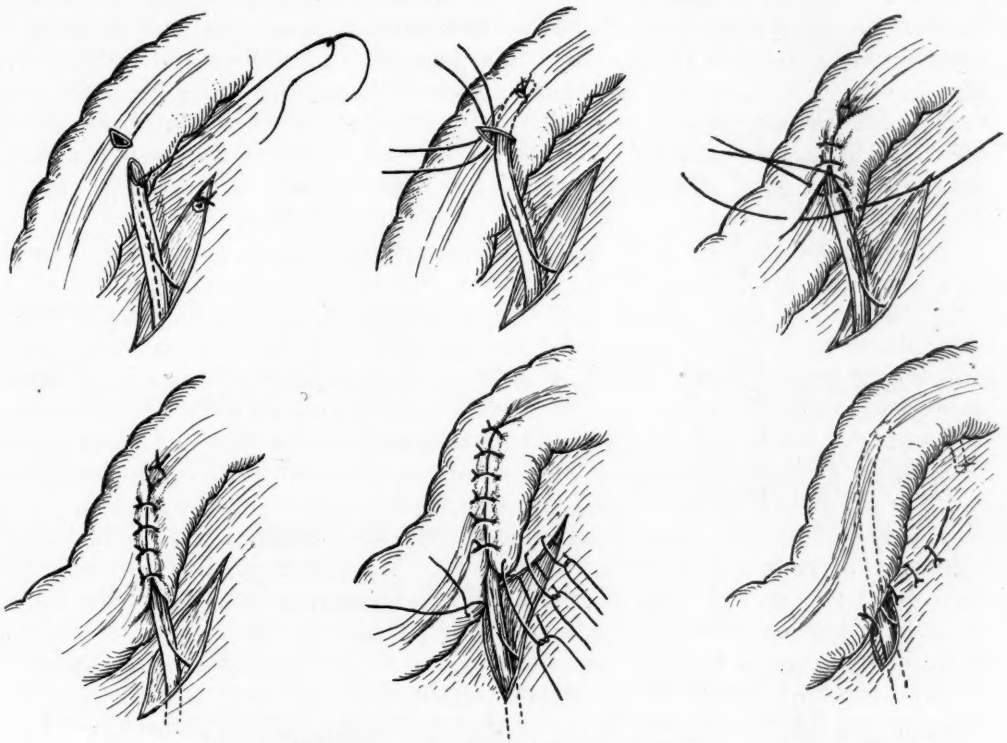


FIG. 89.—Showing implantation of the ureter by the method of Stiles. Note that the ureter is buried obliquely in the bowel wall, and not entirely in the length of the bowel as shown in the original illustrations in Sir Harold Stiles' paper.

all cases, continence becomes complete. When the renal function has become established any necessary plastic operation for the repair of the deformity is carried out.

All but two of my cases have been operated upon by this method, because I recognized that with so rare an abnormality only a few opportunities would occur to any one surgeon, and I thought it better to gain a useful experience in some one method of proved efficiency rather than to try afresh the numerous plans which have been stoutly advocated from time to time.

The congenital defects for which the operation has been carried out have been the various degrees of exstrophy of the bladder and epispadias with incontinence, in both sexes. The frequency of these conditions is difficult

to estimate. For a very long time the existence of the condition of epispadias in the female was overlooked, and, as effective treatment was not thought possible for that condition in the male when complicated by incontinence, many cases were discouraged from seeking surgical advice. Although doctors may be in extensive practice for many years without encountering a single case, the experience of all large hospitals shows that a considerable number gravitate to such centres every year. In the Mayo Clinic, up to the end of 1927, they had treated 115 cases,[3] and at an earlier date, among 367,000 patients seen at the Clinic, there were 69 suffering from exstrophy of the bladder. The latter deformity is stated to occur once in 50,000 or 30,000 births. On this basis Lower[4] states that 2,000 examples of the deformity must occur in America every year. In a paper by C. H. Mayo and William A. Hendricks,[5] the following statement occurs: "Statistics show that 50 per cent of all persons afflicted with exstrophy are dead by their tenth year, and 66·67 per cent are dead by their twentieth year." From my own personal experience I doubt very much if this is really a natural mortality, and I suspect that if it occurs it is largely the result of neglect.

I have watched seven of my patients survive from their earliest infancy and arrive at a stage at which operative measures could be hopefully contemplated. The mere presence of the deformity in no way interfered with their development, and, except for the annoyance of the incontinence, their upbringing has not been especially difficult, though some of them have been subject to crying fits which have been embarrassing because difficult to explain. No special local treatment has been carried out except that the parts have been kept constantly covered with a greasy cloth to protect the delicate mucous membrane of the exposed bladder from irritation by the napkin. For this purpose vaseline has been found best. The children are bathed and otherwise attended to in the ordinary way. Whenever possible the mothers have been seen at an early stage and have been encouraged to give the same devoted attention to these children as they would to their normal offspring. Only in one case, a baby of less than twelve months, did I observe signs of neglect, and in that particular instance, if the child had been left in charge of the parents, I think it is highly likely that it would have succumbed from this cause. It was thin and ill-nourished and suffered from prolapse of the rectum, made worse by fits of prolonged crying. Dr. Dunlop Lickley very kindly admitted the child under his care to the Children's Hospital, and with ordinary attention the baby progressed normally and had no recurrence of the prolapse. Six months later the anal sphincter was perfectly competent, and there was no evidence of unusual laxity of the lower bowel (*Case* 14).

In addition to the 17 cases here recorded, I have seen several others who have attained maturity, and in only one, an example of epispadias in the female, in which the patient had reached the age of 26 years, was there any definite evidence of renal infection, and that patient subsequently died at 31 from that cause, no operative interference having been attempted.

The principal facts connected with my own series of cases are set out in the following table, and the full details will be found in the notes of the cases which follow.

TRANSPLANTATION OF URETERS FOR CONGENITAL DEFECTS: CASES AND RESULTS TO END OF 1927.

NO.	INITIALS, SEX	AGE AT OPERATION	DATE OF OPERATION	STAGES	RESULT	YEARS SINCE OPERATION	PRESENT CONDITION	REMARKS
1	F.B., *m.*	8	Dec., 1912	Two	Cure	15	Quite well	
2	E.T., *f.*	22	Dec., 1914	Two	Cure	13	Quite well	Married since operation; 2 children
3	W.K., *m.*	19	March, 1917	Two	Cure	$10\frac{10}{12}$	Quite well	Slight incontinence at night only
4	E.L., *f.*	20	May, 1917	One	Died			Peritonitis
5	V.K., *f.*	6	Nov., 1917	Two	Cure	$10\frac{2}{12}$	Quite well	
6	J.T., *m.*	13	May, 1919	Two	Died			Peritonitis
7	W.P., *m.*	5	May, 1920	Two	Cure	$7\frac{7}{12}$	Quite well	
8	N.B., *m.*	13	Jan., 1921	One ureter only	Cure	$6\frac{11}{12}$	Quite well	
9	T.L., *m.*	4	Nov., 1921	One	Cure	6	Urinary fistula after plastic on bladder	
10	J.F., *m.*	$10\frac{1}{2}$	March, 1922	Two	Cure	Well for 3 years and 3 months, then died from intestinal obstruction		
11	E.H., *f.*	$2\frac{7}{12}$	March, 1923	One ureter only	Died			Peritonitis
12	J.P., *m.*	10	Oct., 1924	Two	Cure	$3\frac{2}{12}$	Quite well	
13	W.B., *m.*	4	Sept., 1925	Two	Cure	Well for 2 years and 3 months, then died after plastic on bladder		
14	J.M., *f.*	$1\frac{4}{12}$	May, 1926	One ureter only	Died			Septic dermatitis
15	T.L., *m.*	$8\frac{8}{12}$	June, 1926	One ureter only	Cure	$1\frac{7}{12}$	Quite well	Urinary fistula persists (*see Case* 9)
16	J.H., *m.*	3	Oct., 1927	Two	Cure	Recent	Quite well	Kidney decapsulated. Not yet acquired complete rectal continence
17	G.M., *f.*	$3\frac{8}{12}$	Dec., 1927	One ureter only	Cure	Recent	Quite well	Not yet acquired complete rectal continence

NOTE.—In *Case* 17 the second ureter was transplanted in May, 1928, and the patient continues in good health.

Out of the series of 17 cases there have been 4 deaths directly due to the operation. One patient died over three years and another over two

years after operation, and both had enjoyed good health during the intervening period. Of the remaining 11 patients, 1 is included twice for reasons set out in the case record. This leaves 10 patients alive and well at periods varying from fifteen years to seven months since operation.

DETAILED NOTES OF 17 CASES.

In every case the operation was carried out for the relief of incontinence of urine. The age stated is at the time of the first operation.

Case 1.—**Total epispadias. Transplantation of both ureters in two stages at seven months interval. Recovery.**

F. B., male, 8 years at time of operation. (Reg. Nos. 5249 and 5250.)

History.—This patient was a rather delicate and under-sized weedy-looking boy, the fifth child among seven born of not very robust parents. Unfortunately no record was kept of his weight or height. He came under observation when 8 years of age, having suffered from incontinence of urine from birth, the result of total epispadias with separation of the symphysis pubes.

First Operation, May, 1912.—The right ureter was implanted into the sigmoid, after the method described by Mr. (now Sir) Harold Stiles[2] (*see Fig.* 89). The boy stood the operation quite well, but developed a severe attack of whooping-cough during convalescence, and it was not until seven months later that it was judged the second ureter could be safely transplanted. He had not quite got rid of his cough, and when re-admitted to hospital he was found to be rather thin and white.

Second Operation, Dec. 6, 1912.—Anæsthesia by open ether. The Trendelenburg posture was used, and the middle line incision re-opened. A little clear fluid was present in the peritoneal cavity. There were only a few flimsy adhesions and the pelvis was easily exposed. The pelvic colon was large and thick-walled, and the rectum was so much distended as to occupy nearly the whole pelvis. The right ureter could be plainly seen lying on the rectal wall and running into it. It was not obscured by adhesions and was securely healed. It was dilated to about twice the normal size, but when vermiculating it appeared to return to its usual size. Many small glands were seen along the line of this ureter as it lay on the rectal wall.

The left ureter, which was normal in size, was implanted into the bowel, a little higher up than its fellow, but by exactly the same technique which had been employed on the right side. The anastomosis made on the left side was a little less oblique than that on the right. At the end of the operation the ureter was noticed to pass from the pelvic wall at more or less of a right angle, and the part above was already a little dilated, suggesting some slight obstruction. In the hope of arresting sexual development half an inch of both vasa were excised in the pelvis and the ends were allowed to retract. The operation occupied about an hour.

Progress.—Immediately after the operation the boy was extremely shocked; he had difficulty in breathing and became very blue. The pulse was irregular and soft. After oxygen and saline infusion the condition improved. The patient had a restless night, but looked much better next day, though the respirations were very rapid. However, he steadily improved, and a fortnight after operation was very well indeed and the wound was quite sound. He required to use the bed-pan six or eight times a day and about twice at night; very seldom had wet beds and then not much. On the sixteenth day he was allowed to return home, where he rapidly acquired good rectal control. His mother made a practice of getting him up to empty the rectum just before she retired for the night and again first thing in the morning. During the day he had no trouble whatever, and went to school and took part in the usual games and mischievous pranks beloved of boys of his own age.

April, 1917 (four years and four months after the completed operation): The boy had kept very well until the previous winter, since when he had suffered from cramp in the stomach, pain in the loins, and weakness of the legs. He looked thin and ill-developed and was too small for his age. The pulse was weak and of poor tension, but he took his food very well. The bowel had to be emptied after every meal and about twice each night. Control was usually good, but there was sometimes a slight accident if he was not able to relieve himself immediately. The evacuation was like dirty water and smelt badly.

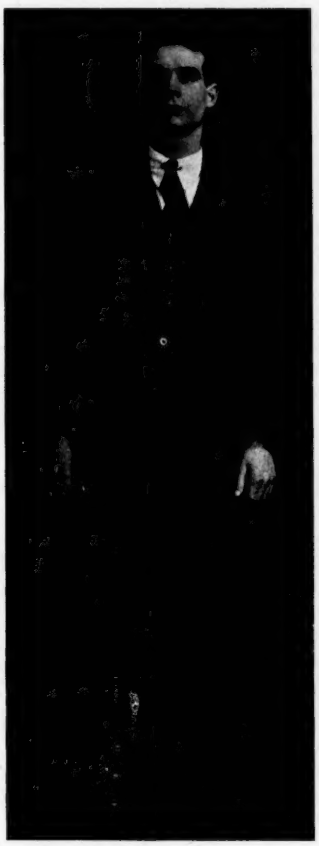
In April, 1918, he was just over 14 years of age, and weighed 4 st. 3 lb. 2 oz. By this time his general health was much better and he looked well and was able to run about all

day and sometimes played football. He wanted to begin work as an errand boy, but the firm required a doctor's certificate before they would allow him to start. As a rule he went to bed about 9.30, and was awakened when his parents retired at 10.30 in order that he might empty the rectum. After this he was usually not disturbed again until about 7 a.m. Sometimes he had to get up once during the night, but he never wetted the bed.

In November, 1920, just eight years after the operation, he was aged 16 but still looked small and thin for his years. He then weighed 4 st. 12 lb. 3 oz. The boy was quite well, took food well, and had never been under a doctor since the operation. The rectum was emptied not more than three or four times during the day and at 10.30 p.m., and then not again till 6.30 in the morning, which was the time he had to get up and go to work. As a rule fæces and urine were intimately mixed, but he did occasionally pass a solid evacuation. On the day that he came to the hospital to show himself, after waiting for two and a half hours, he passed 10 oz. of urine. He was then employed as a rivet catcher and earning twenty-five shillings a week. In his spare time he idled exactly as other lads of his own age, and was very fond of playing football. He occasionally suffered from cramp in the bowels and diarrhœa, and lost about two days every month from this cause. The scar of the incision was strong and there was no hernia. The testicles were of normal size and secondary sexual characteristics were developing.

During 1922 this boy kept very well, but was out of work on account of industrial depression. Towards the end of that year he looked thin and poorly, and was found to be developing knock-knee. Both femora were affected, and there was marked down-growth of the internal condyles. When admitted to hospital for the treatment of this condition he was 18 years of age. He was rather anæmic and seedy and there was evidence of generalized rickets, as shown by thickening of the epiphyses and by a marked rickety rosary. He was able to hold his water for five hours without emptying the rectum, never wet the bed, and only occasionally had to get up at night. The evacuation varied a good deal, being sometimes clear like ordinary urine, or a thick, brown mixture, or very rarely a solid stool.

In October, 1922, I operated for the genu valgum, carrying out Macewen's osteotomy on both sides (Reg. No. 14750). The operation was performed under ether anæsthesia, and the patient was kept under its influence for over an hour until the plaster was applied to both sides. Recovery was uninterrupted, and he was able to leave the hospital on the ninth day, not in any way upset by his experience. The ultimate result was very satisfactory, and under supervision and a suitable régime the rickety condition very soon improved.



a

b

FIG. 90.—*Case* 1. F. B. Photographs taken 15 years after transplantation of ureters, showing: (*a*) General development; (*b*) Genital development.

In February, 1926, the boy was out of work for a short time with 'lumbago' and was attended by his family doctor. By June of the same year he again complained, and was put down as suffering from the same complaint and debility. Since then he has been attended for 'looseness of the bowels' and for influenza colds, but has had no further symptoms that could fairly be attributed to his disability. The family doctor informed me that he had only once attended him for an attack in which he suspected ascending renal infection.

In May, 1926, this patient was shown at a meeting of the Association of Physicians. He was then in ordinary good health and made no complaint of any sort. The opportunity was taken to examine the urea content of the urine and blood, with the following result: Urine urea, 0·62 per cent; blood urea, 52 mgrm. per 100 c.c. This examination, therefore, indicated some degree of renal inefficiency. On Dec. 31, 1927, his 24th birthday, he was 5 ft. 4½ in. in height, and weighed 7 st. 9 lb. His general health was quite good and he appeared normal in every respect, but still looked rather thin and not very robust (*Fig.* 90 *a*).

He urinates, per rectum, after breakfast, dinner, and tea, and at bedtime. Sometimes he gets up once in the night if he drinks a large quantity of water, of which he is very fond, but he never wets the bed. The evacuation is usually mixed fæces and urine, but at times he passes a normal stool, and states that he can pass wind without water. The lad smokes about fifteen cigarettes a day. The pelvis is well developed and the pubic bones look normal in the X-ray picture, but they are separated by half an inch and are not on the same level. The lower ends of the femora and upper part of the tibiæ are quite normal. The penis and testicles are well developed, and there is a free growth of hair to the umbilicus (*Fig.* 90 *b*). Occasionally he has experienced an erection and has had nocturnal emissions.

The patient left home about 9 a.m., just after emptying the rectum. About 1 o'clock he had dinner in the hospital, and just after his meal felt as if he wanted to empty the rectum but did not do so. About 1.15 an examination with the sigmoidoscope was carried out. The anus looked normal and grasped the finger firmly. The lower rectum was empty, but when the instrument had entered to about the length of the forefinger, urine commenced to well up into the field from the bowel above, flooding the intrument. In this way about a pint came away and then the boy sat down on a chamber and passed a good deal more. The total evacuation, which was almost entirely urine, was found to measure 29 oz. The rectum and sigmoid appeared normal, and there was really nothing to remark except perhaps a rather unusual moisture of the mucous membrane. A thorough search carried out for about half an hour quite failed to locate the ureteral openings. Indigo-carmine was not used.

Summary.—Case of complete epispadias in the male with total incontinence of urine. Operation at 8 years of age. Transplantation of both ureters into rectum and sigmoid at an interval of seven months. Good recovery. Has enjoyed almost normal health since operation and has engaged in work and play like other boys of his age. In December, 1927, fifteen years after the last operation, he was 24 years old, was quite well, weighed 7 st. 9 lb., was 5 ft. 4½ in. high, and had perfect rectal function and control.

Case 2.—**Epispadias with incontinence. Transplantation of both ureters in two stages at one month interval. Recovery.**

E. T., female, 22 years at time of operation. (Reg. Nos. 7338–7339.)

History.—This patient was admitted complaining of inability to retain more than a few drops of urine. The condition had existed since birth. At 10 years of age she was admitted to a hospital and examined under chloroform, but was told that nothing could be done to remedy the disability. Between 18 and 19 years of age she was again in hospital on four separate occasions, and had as many local operations carried out. At that time when she was lying on her back she could keep dry for a short time, but as soon as the bladder began to fill it overflowed. When up she was constantly wet. At one of these operations the anterior wall of the bladder was separated from behind the pubes and split from the urethra upwards for an inch. The margins were then sutured together right down into the urethra with the object of diminishing its calibre. At the end of twelve days she went home much improved, having only wet the bed once since the operation, but the improvement was only temporary, and she was soon as incontinent as ever.

When admitted to the Newcastle Infirmary, in November, 1914, she was found to be a good-looking, healthy girl, but shy and sensitive. The underclothing was constantly wet and uncomfortable and she had always a urinous odour. The skin of the thighs was reddened and sore from the irritation. Locally the vulva showed the deformity associated

with epispadias in the female. There were scars of previous operations. The two halves of the pubes could be felt separated to the extent of about an inch.

First Operation, Nov. 17, 1914.—Median incision below the umbilicus. The ureter on the right side was exposed and transplanted into the upper rectum by the method of Stiles.

Progress.—The patient went on well until Nov. 26, when the temperature began to rise and she complained of some pain in the right side of the back. There was a trace of albumin in the urine. By the end of a fortnight the temperature and pulse had fallen, the patient was feeling much better and had no pain.

Second Operation, Dec. 18, 1914.—Just a month after the first operation the abdomen was re-opened. There was some free fluid in the pelvis. The small intestine was adherent to the sigmoid where the ureter had been implanted. These adhesions were separated and the implanted ureter was found distinctly dilated. The left ureter was now anastomosed into the sigmoid in exactly the same manner as the right, but at a slightly higher level in the bowel. The abdomen was closed in layers.

Progress.—After the operation the patient's temperature and pulse were elevated and she had severe pain in her back on both sides. She became a little thin and anæmic. By the end of a fortnight urine could be retained in the rectum for two hours. The wound was perfectly healed and the patient felt much better. She was discharged with full instructions concerning the taking of urotropin, etc.

When she first returned home she lost appetite, complained of weakness and got very thin, and her own doctor said that he thought that she was going into a decline. At the end of February, 1915, she went to the South of England and stayed for some months. The change did her a great deal of good.

Just about a year after the last operation the patient reported by letter that she was very well with the exception of headaches and occasional pain in the back. Her object in writing was to ask advice *re* marriage. Knowing full well that contrary advice would certainly be disregarded, the patient was informed that there would be some extra risk, but that, if she was anxious to marry, she need not be deterred. She married in November, 1916, and in December reported herself as very well. She still took urotropin and thought it proved beneficial. In April, 1917, this patient asked advice about having children, and elected to take the risk. At this time she reported that the frequency of urination depended upon her general health. When feeling quite well she only emptied the bowel three times a day, and not at all during the night. On the other hand, when not feeling well, she urinated about every two hours by day and about four times each night. Rectal, or rather sphincter, control was very good, and she had only once had a little incontinence after taking some purgative pills. She often had pain across the back, and towards the end of 1917 had often to go to bed for a day or two on that account.

Each year, in December, the anniversary of the operation, she reported on her condition, and at the end of 1918 (the fourth anniversary) the report was very satisfactory. The pains in the back and the headache were often severe, but were always promptly relieved by a few tablets of urotropin. In October, 1919, nearing the fifth anniversary, the patient reported herself as pregnant. There was a good deal of backache, made worse by worry as to the approaching confinement, and as to whether the baby would be similarly affected. The confinement proved to be normal in every way. She was in labour eighteen hours, and delivered herself of a healthy child on April 8, 1920. There were no complications in the puerperium, and in July the patient reported herself in better health than ever before, and she was able to nurse her child for twelve months. There was an abundance of milk.

About the time of the sixth anniversary, in December, 1920, the patient came to see me at the Infirmary with her baby. She was looking and feeling very well and able to take ordinary food, and expressed herself as better than ever before, and as delighted with the result of the operation. She supplied the following information as to her daily routine. Her work was to attend to the usual household duties and the care of her child, and also to look after a small confectioner's shop which she and her husband had started to supplement their income. In these duties she got a little help from a young maid. As previously reported, the emptying of the rectum depended a good deal on her general health, but she could go to the 'pictures' and sit through the performance without discomfort. As a rule she was able to lie all night, but sometimes had to get up as often as four times. She did have pain and discomfort if she wanted to evacuate the rectum and had to wait to do so, but there was never any involuntary escape of rectal contents. There was still a good deal of headache and backache.

In 1921 this patient reported herself pregnant again; she was very well except for a little bearing down, but was able to continue her work. The second baby was born without the least trouble, and the patient again made an uninterrupted recovery. During 1925 the patient had a good deal of trouble with her 'kidneys' and was often under the doctor,

especially in the warm weather, when she seemed to be worse; at such times she had to empty the rectum about every half hour.

On December 29, 1927, she came to report—just thirteen years after the last operation. She was then 35 years of age, measured 5 ft. 1½ in. in height, and weighed 7 st. 2 lb. Her general health was excellent, and her children of 7½ and 5½ were thriving well. She looked fit and well, and certainly better than at any previous visit (*Fig.* 91). It was especially noticed that her teeth were well preserved. At that time she occupied a house of five rooms in a seaside resort, and ran a business in an industrial town a few miles away. She kept one maid at home and two girls in the shop. Her daily routine begins when she rises at 9 a.m. and empties the bowel before breakfast (takes ordinary food, but has a poor appetite). She then travels by train to her business, where she arrives about 11 a.m., and all day she is occupied in the shop, returning home at 10.49 p.m. Other days the hours are shorter, and one day a week she does not go to business. On Fridays she goes at 9 a.m., and does not return to her own home until Saturday at tea-time. When in normal health she empties the bowel about every three hours, and is able to hold the contents for longer if necessary. At night she gets up once at about 6 a.m., and never has an accident. When not so well, and especially in warm weather, she has to go often during the day, but never more than twice at night.

FIG. 91.—*Case* 2. Mrs. A. W. S., age 36, with her children, born 7 years and 5 years after both ureters had been transplanted into the recto-sigmoid. She is now in good health, with perfect rectal function and control, 13 years after operation.

Nearly always the evacuation is a mixture of fæces and urine. She thinks she passes a lot because she drinks a lot of water. She is able to pass flatus independently of emptying the bowel. The menstrual time is regular, but there is a good deal of pain. The headaches are not so bad as before; her eyes have not been tested. Backache is very infrequent now, and only comes on if she gets a little cold or during menstruation. It is always on the right side and lasts not more than a day. The presence of the backache makes no difference to the evacuation.

On this occasion the bowel was examined by the sigmoidoscope. On request the patient emptied the rectum, voiding 2 oz. of clear urine with a large quantity of mucus. This had collected between 11 a.m. and 1 p.m., and the patient said there would have been much more if she had been drinking as usual. The skin about the anus was normal, and the sphincter was very tight, but not irritable. The mucous membrane of the rectum and sigmoid were unusually moist, but otherwise normal. The opening of one ureter was seen on a ridge; there was no vermiculation and no spurt of urine, only a steady suffusion with very clear water. This was about 8 to 10 in. from the anus. The indigo-carmine test was not used. The examination of urine resulted as follows: Reaction, alkaline; albumin, a trace; blood, nil; urea, 1·5 per cent; fair amount of mucus; microscopically, a few pus cells and one or two red corpuscles, triple phosphate crystals, no casts. Blood-urea, 27 mgrm. per 100 c.c. X-ray examination showed that the pubes were curiously pointed and were separated to the extent of $\frac{7}{16}$ in. The pelvis was flat, the greatest breadth being 6⅛ in. The patient did not complain of any difficulty or weakness in walking, and the pubic bones appeared to be firmly held together by a very strong ligament.

Summary.—Case of epispadias in the female with total incontinence. Operation at 22 years of age. Transplantation of both ureters into recto-sigmoid at an interval of one month. Good recovery. Has enjoyed almost normal health since operation. Married, and has had two children born five years and seven years after operation. In December, 1927, thirteen years after operation, the patient is 36 years old and is in better health than ever before; weighs 7 st. 2 lb., is 5 ft. 1½ in. high, and has perfect rectal function and control.

Case 3.—**Ectopia vesicæ. Transplantation of both ureters in two stages at twenty-four days interval. Plastic on bladder. Prolapse of small intestine through wound causing intestinal obstruction. Recovery.**

W. K., male, 19 years at time of operation. (Reg. Nos. 13708–13711.)

History.—Patient was one of a family of four brothers and two sisters, who were all healthy. Parents alive and healthy, though the father was alcoholic. The patient himself had never been to school and had only worked about the house. He took regular outdoor exercise, smoked cigarettes to excess, but did not take alcohol. Until three years ago he always lived in the country. Had suffered from measles, but had never had any other illness. Some days felt out of sorts and unfit for exertion. He was a big lad, well built and muscular, but slightly anæmic. The speech was slow and intellect 'simple'. Pulse slow and regular. Locally he presented the typical deformity of ectopia vesicæ, with wide separation of the pubes. No previous treatment had been attempted.

First Operation, March 6, 1917.—General anæsthesia. Left ureter implanted to upper rectum by method of Stiles. The vas was exposed at its entrance into the internal ring and severed, the ends being encouraged to retract. The abdomen was closed by interrupted and through-and-through silkworm sutures. The whole operation took one hour. Anæsthetic was taken well, but the abdomen remained fairly rigid throughout. The patient had a little pain and some anæsthetic vomiting, but otherwise made a good recovery.

Second Operation, March 30, 1917.—The old wound was opened up. The site of the previous anastomosis was found to be surrounded by adhesions of small intestine. At this stage the incision was lengthened about one inch in a downward direction, and it was noticed that a thick fibrous ring was severed round the extroverted bladder. The right ureter was transplanted in a similar manner to the left, but at a lower level. Right vas divided. Abdominal wound closed by through-and-through sutures.

Progress.—The day after the operation the patient had slight cough and much anæsthetic vomiting. The abdomen was tender but not distended. Next day the vomiting and cough persisted and the pulse was quick. On the following morning the patient was still vomiting and complaining of severe pain. The wound was examined and appeared to be normal. At 8.0 p.m. the vomit was noticed to be intestinal in character. The wound was again examined and about three inches of lymph-covered small intestine and a small piece of omentum were found protruding through its lowest part.

Third Operation, April 2, 1917.—As the patient refused a general anæsthetic, spinal was employed. This was slow in acting, and he alleged that he never completely lost sensation in his abdominal wall, though he allowed the operation to be completed without interference. The protruding omentum was ligatured and excised. The lymph was removed from the wall of the gut and the latter was reduced by pressure. No attempt was made to close the parietal opening, which was packed and protected by a graduated pad of gauze. After the operation the vomiting ceased and the patient expressed himself as greatly relieved.

Progress.—The next day the patient was doing well, although he still had pain and felt rather sick. From day to day afterwards he steadily improved, and by April 21 he was very well, though obviously a little anæmic. The wound was practically all healed; there was no evidence of renal infection. He could retain urine in the rectum for two hours and sometimes over three. At night he sometimes evacuated the contents of the rectum during sleep.

By April 27 the patient having revised his opinion of general anæsthesia, another operation was performed under ether.

Fourth Operation.—The bladder mucous membrane was dissected from its bed. Great difficulty was experienced in carrying out this procedure owing to excessive hæmorrhage. Numerous vessels were ligatured, but most of the bleeding took place from cavernous-like tissue existing under the lower part of the mucous membrane. The hæmorrhage having been dealt with, an attempt was made to draw together the two edges of the wound, but this was found to be impracticable owing to the tension of the abdominal wall. Finally the unclosed wound was packed with gauze. The pulse at the end of the operation was 120, and the patient was pale and collapsed from loss of blood,

but quickly recovered with the raising of the foot of the bed. After this anæsthesia he suffered very little from vomiting.

This operation was again well borne, but the next day he had frequent and sudden evacuations. From May 2 he had slight evening rise of temperature, and for a day or two complained of severe pain in the bowels on using the bed-pan. On May 9 he retained his urine for five and a half hours, and by the 19th he was well enough to be discharged to the out-patient department, the wound healing satisfactorily. Inquiries made as to sexual feelings produced a negative reply.

Early in June—that is to say, two months after the second ureter was transplanted—the urine passed per rectum was examined bacteriologically. With the smallest dilution which could be employed the colonies on nutrient media were far too numerous to count. The bacteriological fauna was indescribable, but the prevailing organism was undoubtedly *Bacillus coli*. Urotropin was given for a week, and the examination repeated, but the result was the same, there being no appreciable difference in the number of colonies.

In the beginning of September the patient came to report. He looked very well—better than before operation—and said that he was pleased it was done. He was taking food well, but complained of some pain in the right loin. He passed urine about every two and a half hours during the day and several times each night, and the bed was always wet. The bladder area was now healed except for a granulating area at the root of the penis.

Soon after leaving the infirmary he went to stay with a sister in the country and began to work on a farm, and he has followed this employment, with only occasional interruptions, ever since. In July, 1920, he stated that he habitually worked from 6.30 a.m. till 5 p.m. and often until 7 p.m. During the day he was unable to retain urine for more than one and a half hours without getting wet, and during the night he had to get up three or four times, being awakened by a slight pain in the hypogastrium. The evacuation was nearly always fæces and urine intimately mixed, but occasionally he passed a solid motion. There was no pain in the back or headache, but he suffered very much from thirst. He stated quite definitely that he had no sexual feelings whatever. He voluntarily stated that life was worth living since operation, though it was not worth while before.

In November, 1920, I had an opportunity of examining this patient. He was strong and well and had been working on the farm regularly without trouble. He was then 22 years and 10 months old and weighed 10 st. 6 lb. There was a certain degree of ventral hernia, but this caused him no inconvenience. During the day he emptied the bowel every two and a half hours. At our request he provided a sample of the contents of the rectum; it was a mixture of urine and fæces, and measured 5½ oz., which had collected in four and a quarter hours. During the night he had to get up once or twice, and had some incontinence, but that was improving. There had been no attacks of pain in the back nor of fever. Sexual feelings were absent, but he did occasionally have an erection. From every point of view he looked on the result of the operation as a great success.

After this time the nocturnal incontinence became worse, and early in 1921 was looked upon as a great nuisance by those with whom he lodged. In March, 1922—i.e., five years after operation—he was seen and was found to be quite well, but not in very good condition, as he had been out of work owing to industrial depression, and had not been getting proper food. During the day he emptied the bowel about every two hours. At night if he slept heavily he had incontinence, but if he awakened to evacuate the bowel this was avoided. About this time he complained of scalding of the anal region, and the skin around was soddened and whitened as if subjected to constant moisture.

In August, 1923, I saw this patient in his first bad attack of renal infection. His mother informed me that up till two months previously he had been splendidly well in every way, and had very often slept all night without incontinence. During the last two months he had been losing ground, became thinner, and was much troubled with cough.

The attack for which I was consulted began on Saturday, July 28. He then felt ill and had pain in the back and vomiting. When seen by Dr. Hammond, of Gateshead, he was found to have a temperature of 104°, and later 105°, but there had been no rigor. At the time of my visit he was very flushed and had a temperature of 101°, and the mouth was dry and parched, but he was perspiring freely and said that he was much better. There was pain in the left kidney region and some acute tenderness behind, but no enlargement of the kidney could be made out. The right side was quite free. During this febrile attack he complained that the urine had escaped from the bowel involuntarily. I ascertained that he had omitted to take his potassium citrate for a considerable time. Without any special treatment he soon made a complete recovery and resumed his work in the country, which he continued without much interruption.

I did not hear from this patient again until July, 1927, when I learned that he was not well, and I went out to the country to see him. I found that he had been out of work a good deal in 1926 owing to the general industrial conditions. He lives with his sister, a married woman in humble circumstances with five children, and I have no doubt that when work is short they often do not get enough to eat. In the beginning of June, 1927, the patient began to complain of pain in the right side of the back and in the right leg, and of weakness and loss of flesh. His sister noticed that he was "hangy" and obviously not well. He felt sickly, though he never vomited. The incontinence at night was very troublesome, and happened occasionally during the day, depending on his general state. In spite of his condition he was able to do a little light work on a farm. I found him rather thin—weight 9 st. 1 lb.—but otherwise looking in fairly good condition, and I observed that his clothes were not particularly smelly. There was no sign of enlargement of either kidney, and he was not tender in the loins. The skin about the anus was again normal. It was obvious that he walked with rather a waddle, but that was always so, and its being worse probably depended on his not very good health. Under treatment with large doses of potassium citrate he quickly improved and gained weight, so that by the beginning of December, when he came to the hospital for a period of observation, he was found to be 10 st. 7 lb., a gain of 20 lb. in about four months. His height was 5 ft. 10 in., and he looked in the robust health of an ordinary countryman, and by this time his only complaint was of the nocturnal incontinence. The local deformity now consists of a total epispadias, but the penis is large and the testicles are well developed. X rays showed a well-developed pelvis with a separation of 3½ in. between the pubic bones.

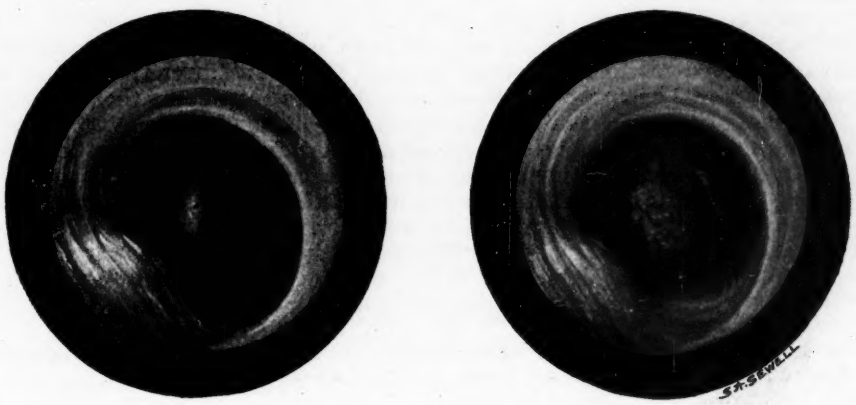


FIG. 92.—*Case* 3. W. K. The appearance of the ureter as seen with the sigmoidoscope: on the left in the resting state, on the right during vermiculation and after the exhibition of indigo-carmine. The prominence of the internal iliac artery is well seen.

The daily routine he described as follows: He rises at 5 a.m. and goes to the farm, a walk of 2½ miles, to be there by 6.30. Works until 6 p.m. in summer and until dark in winter. In addition to work about the steading he goes to the fields, ploughs, drills, forks hay, etc., etc. He empties the rectum three or four times a day. At night has never acquired continence, and urine escapes involuntarily and he is quite unconscious of the leakage. In spite of this he sometimes passes some urine on first rising in the morning. He is *not* able to void flatus without leakage. The appetite is good and he is able to take any kind of food and in any quantity. The evacuations are as before, and the rectum is of good capacity, for at my request, but with an admitted effort, he retained urine from 6.30 a.m. to 10 a.m. and then passed 18 oz.

He has had a kidney attack nearly every year since the operation. During these attacks he has to remain in bed from a few days to a fortnight, and after that it takes about a week to convalesce. The attacks are now always on the right side. He has pain, fever, and frequent micturition, but never vomits. The skin of the buttocks and the anus now look almost normal, and the latter grasped the finger very well.

A sigmoidoscopic examination was made, and the rectum was emptied just before coming to the theatre. On introducing the instrument the mucous membrane was noticed to be redder than in the other cases examined about the same time. The lower rectum was empty, but on advancing the tube to just beyond the first fold

quite a quantity of urine gushed out—several ounces—as if it had been imprisoned above some valve.

The search for the ureter was not at first successful. The internal iliac artery was noticed to be pulsating very freely and vigorously. Further search revealed one ureter at about this level, i.e., 8 in. from the anus. The ureter hung into the field just like the uvula, and was recognized by the vermicular movements. It moved easily and wobbled about on introducing air with the bellows. The appearance is faithfully represented in the coloured drawing (*Fig.* 92). The ureter nipple was bright pink in colour, in contrast to the lighter bowel wall. It vermiculated like the normal ureter and was then drawn up a little and became a lighter pink, then relaxed and at times became bright red in colour. Urine could be seen dripping pretty freely from round about the nipple. Indigo-carmine, 4 c.c., was given by intramuscular injection, and in seven minutes the blue urine could be seen escaping in little gushes from the spot at the side of the base of the nipple, as indicated in *Fig.* 92. So it continued, the effluent getting all the time darker, until at twenty minutes the examination was discontinued. By that time 2 to 2½ oz. of blue urine had been collected. The other ureter could not be found. The one seen was the upper or right ureter, the patient lying on the left side. The examination of the urine collected at this time resulted as follows: Reaction, amphoteric; albumin, trace present; blood, present (pyramidon); urea, 1·50 per cent. The blood-urea from a sample sent on Dec. 15, 1927, was 34 mgrm. per 100 c.c. The lower ends of both forearm bones were examined by X rays and appeared to be normal in every way. Mr. J. S. Arkle kindly examined the fundi for me, but found no evidence of changes in the vessels.

Summary.—Case of ectopia vesicæ in the male with total incontinence, no previous operative treatment having been carried out. Operation at 19 years of age, both ureters being transplanted into the recto-sigmoid at an interval of twenty-four days. Prolapse of small intestine through the wound after the second operation caused intestinal obstruction. Replacement under spinal anæsthesia. A month after the second operation the mucous membrane of the bladder was extirpated, general anæsthesia being employed. Made a good recovery and has been greatly benefited by operation, but has never acquired rectal control at night. Every year since operation has suffered from an attack of renal infection. He has worked fairly regularly as an agricultural labourer. In December, 1927, ten years and two months after the second ureter was transplanted, he was 29 years of age and was quite well; weighed 10 st. 7 lb., was 5 ft. 10 in. high, and had good rectal function and control during the daytime.

Case 4.—**Epispadias with total incontinence. Transplantation of both ureters into recto-sigmoid in one stage. Death from peritonitis and pyelonephritis.**

E. L., female, age 20. (Reg. No. 13712.)

History.—This patient was admitted complaining that she had never been able to retain more than a few drops of urine since she was 3 years old. She was found to be well developed and nourished. All the urine had been allowed to soak into the garments and her condition was distressing and pitiable. No previous operation had been attempted. The local condition was that of epispadias as found in the female, the remaining urethra and vaginal wall being patulous and without muscular tone.

Operation, April 3, 1917.—General anæsthesia. Middle-line incision from just above the umbilicus to an inch above the pubes. The right ureter was exposed, lifted from its bed, divided, and implanted into the sigmoid by the method of Stiles. In this case the pelvis was roomy and the parts very accessible. The operation had been so easy and looked so satisfactory that it was decided to carry out the same method on the opposite ureter there and then. The left ureter was therefore implanted several inches higher up in the bowel. At this stage it was observed that there was a slight kink in the sigmoid opposite the sacrum, which might at any time give rise to obstruction, so the bowel was adjusted and fixed by some additional sutures. The whole operation occupied sixty-five minutes, the patient being an excellent subject for anæsthesia and the abdominal wall being perfectly flaccid throughout.

Progress.—The patient stood the operation very well, but the next day the pulse was rapid and weak, and the tongue dry, furred, and brown, while the temperature was subnormal. There was no abdominal distension, but much tenderness on palpation. She passed urine per rectum, together with a good deal of blood. On the following day she said that she felt better. The temperature was beginning to rise. Saline and whisky were administered intravenously, with further improvement. On the third day the temperature was 102°, and the pulse still very rapid. There was a severe rigor about middle day, and

in the evening the patient complained of pain over the right kidney. On the seventh day the patient was still very ill, but there were no more rigors. The wound was dressed and found to be satisfactory. Urine was passed frequently per rectum and there were no uræmic symptoms. Large hot foments were applied over both kidneys, and 30 gr. of potassium citrate were administered four-hourly. The patient had a good night and the temperature was slightly better. The next day, the eighth, she complained of more pain over both kidneys and both sides of the abdomen. She felt sick, and complained that she was unable to see clearly. Saline with whisky was injected subcutaneously. The evening temperature and the pulse were both improved, and colour and respiration were better. The pain was lessened but there was still vomiting. The patient had a fair night and slept about five hours in stages, and on the ninth day she looked and felt better. The pulse was as before, but the temperature was subnormal. The same evening the patient had a further rigor, and afterwards she became very cold and breathed badly. From this time the condition steadily became worse, and the patient gradually sank and died just eleven days after the operation.

POST-MORTEM EXAMINATION.—Only a hasty examination could be made. The distended small intestine was adherent over the pelvis, and when separated disclosed a large abscess around the sigmoid in the region of the anastomosis. The left ureter was gangrenous and had separated from the bowel, leaving an aperture the size of a threepenny piece in the gut where the anastomosis had given way. The left kidney was greatly enlarged; the pelvis contained a large quantity of pus, and there was evidence of ascending infection from medulla to cortex. Microscopically, this kidney showed acute inflammatory change throughout, evidently of septic origin. The right ureter was in position, but the wall of the gut and outer coat of the ureter had both taken part in the inflammatory process. This kidney showed slight congestion, but no marked change in medulla or cortex. Microscopically there was acute parenchymatous inflammation but no evidence of septic invasion.

Case 5.—**Ectopia vesicæ. Transplantation of both ureters in two stages at three weeks interval. Perinephritic abscess. Recovery.**

V. K., female, age 6 years. (Reg. Nos. 9591 and 9869.)

HISTORY.—This patient had been under observation since she was a day old. Her mother gave the baby devoted attention, and she made good progress throughout, thriving like a normal child. When admitted for operation at 6 years of age she was well nourished and in good condition, but very nervous and shy. There was complete ectopia, with cleft of the mons and vulva and wide separation of the pubes.

FIRST OPERATION, Aug. 28, 1917.—General anæsthesia. Patient placed in Trendelenburg position, mid-line incision. The left ureter was implanted into the rectum by the method of Stiles. Left oöphorectomy also carried out, and the wound closed by through-and-through sutures without drainage.

PROGRESS.—The child stood the operation quite well and seemed very little disturbed. On Sept. 1 there was a little pain in the left side with a rising temperature. By Sept. 4 the pain had disappeared after treatment by the local application of heat. The temperature was down and the patient picking up nicely.

SECOND OPERATION, Sept. 18, 1917.—Old incision re-opened. The site of the previous anastomosis was examined and found to be shut off by omental adhesions. An operation similar to the preceding was performed on the right ureter. The gut was made to overlie the exit of the ureter from its retroperitoneal bed. Wound closed by through-and-through sutures without drainage.

PROGRESS.—After this operation the patient picked up well, but there was some vomiting. From the first she used the bed-pan about four times during the night and had no wet beds. About Sept. 28 she developed pain in both kidney regions. The pulse was rapid but the temperature was not elevated. The abdomen became distended; there was vomiting and some nocturnal incontinence. The patient gradually improved, except that she got steadily thinner and developed a slight evening rise of temperature. She required to use the bed-pan about every two and a half hours. As the condition was not very satisfactory the abdominal wound was opened with sinus forceps and about 10 oz. of pus evacuated. By Nov. 7 the patient was looking better; there was no pain or discomfort and no more wet beds. There was still a little discharge from the lower end of the wound, and for two days an elevation of temperature.

OPERATION, Nov. 20, 1917.—Incision again opened up at the lower end, and a further abscess found in the abdominal wall. Under the anæsthetic a mass in front of the right loin was made out, possibly a perinephritic abscess. Another incision was made close to the right iliac crest, evacuating a retroperitoneal collection. A rubber drain was passed through both incisions. By the end of November the child was so much better that the

drains were removed. There had never been any discharge of urine from the incision. Urine was passed every three hours or thereabouts, and there was full continence. A week later the temperature ran up to 102·2° and the pulse to 120. The child had headache and felt sickly. The abscess was practically healed, but the child was still very thin, the condition being attributed to kidney infection. After this the patient gradually improved and was soon able to leave the hospital. She was seen from time to time and steadily improved, so that in due course she was able to go to school.

In November, 1920, she came to hospital for examination. She was then 9 years and 8 months old, and a well-developed, healthy-looking child, able to take ordinary food, and was never sickly. Weight, 4 st. 6 lb. She was attending school and had risen to be a monitor, and was behaving much as other schoolgirls of her age. The rectum was emptied about five or six times in twenty-four hours, four times during the day, and at night about 3 a.m. and again at 7.30 a.m. She awakened and got up herself. Sometimes at night there was a little incontinence, but never by day. On one occasion the urine passed in twenty-four hours was measured, and found to be 33 oz. Once since leaving hospital she had had an attack of pain on the right side, which disappeared in a few hours after the application of hot flannels, and she was all right the next day. Twice or thrice the doctor had attended her for colds or for fainting at school.

In April, 1921, the patient was admitted to hospital in order to have the mucous membrane of the bladder removed. The opportunity was taken of examining the bowel in the hope of inspecting the orifices of the ureters. There were no signs of irritation about the anus and the sphincter was competent. Under general anæsthesia a soft rubber catheter was introduced into the rectum and about half an ounce of clear, odourless urine, mixed with some muco-pus, was withdrawn. The sigmoidoscope was introduced and the bowel distended. The lining membrane of the rectum was seen to be perfectly clean and normal. The two ureteric orifices were found. The one on the right side was very much reddened, and no urine was seen to come from it. That on the left was more clearly seen, and appeared as a small depression in the mucous membrane. There was no hyperæmia in its neighbourhood, and urine was seen coming from it in a series of spurts, which enabled its location to be certainly identified. After this examination the patient was turned on her back and the bladder dissected up from the abdominal wall. There was a good deal of troublesome hæmorrhage. Catgut sutures placed horizontally helped to close the hiatus which remained. The labia were then partially undercut, the incisions being carried well up on to the abdominal wall to relieve the tension. These were then opposed with silkworm gut. The clitoris was bifid, the vaginal orifice was almost vertical, and was about the size of a normal adult female urethra. It was incised backwards and its mucous membrane stitched to skin. It was very difficult to get the halves of the vulva together on account of the wide separation of the pubes. It could only be done by wide lateral undercutting, and even then there was considerable tension. The patient was under anæsthesia for an hour. She was not unusually upset, and made an uninterrupted recovery from this interference. On this occasion the urine was examined bacteriologically, but the flora was indescribable, and the colonies were much too numerous to count.

In March of 1922 the girl was very well and was developing rapidly, hair commencing to grow on the vulva. Continence was good and she never wet the bed. In 1925, at the age of 14, she began to menstruate normally. Early in 1926 she was better than ever before. In August of the same year the blood-urea was found to be 55 mgrm. per 100 c.c. This definitely raised content in a person of her age was taken by Dr. Spence to indicate some slight impairment of renal function. At this time a further plastic operation was carried out for the restoration of the vulva, the mons being still deeply grooved and somewhat unsightly. General ether anæsthesia was again employed, but the patient was in no way upset and made a normal recovery. During 1926 she had a febrile attack with pain in the right kidney region and was laid up for two weeks. While thus affected she required to empty the rectum more often. In August, 1927, a year later, she was quite well and was able to spend her holidays from home. She then wrote, "When I was younger I could not get away like other girls of my age, but now that I am better I am pleased to say that I can do so. I have spent my holidays in Edinburgh this year and I feel quite well."

In December, 1927, she was splendidly well in every way, and weighed 8 st. 9 lb. and was 5 ft. in height. She looked robust and was bright and cheerful (*Figs.* 93, 94) and was learning to be a hairdresser; she left her home at 3 p.m., went a car journey of half an hour, and did not get home until 9.45 p.m. During this time she only emptied the rectum once. In the ordinary way she rises at 8.15 a.m. and empties the rectum, not again until about 12, then at 3, just before going out as a matter of precaution, and after that not until 9 or 10 o'clock. She usually gets up once at night, never more than twice, and never wets the bed. She was not able to say whether she can pass wind, but has not observed and has certainly not been bothered. The opportunity

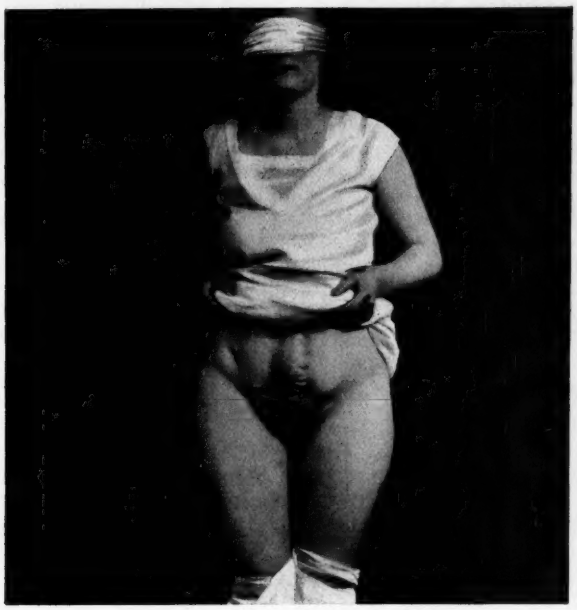


FIG. 93.—*Case* 5. V. K., at 16 years of age, 10 years and 2 months after operation. Height 5 ft., weight 8 st. 9 lb. The photograph shows the general nutrition and development.

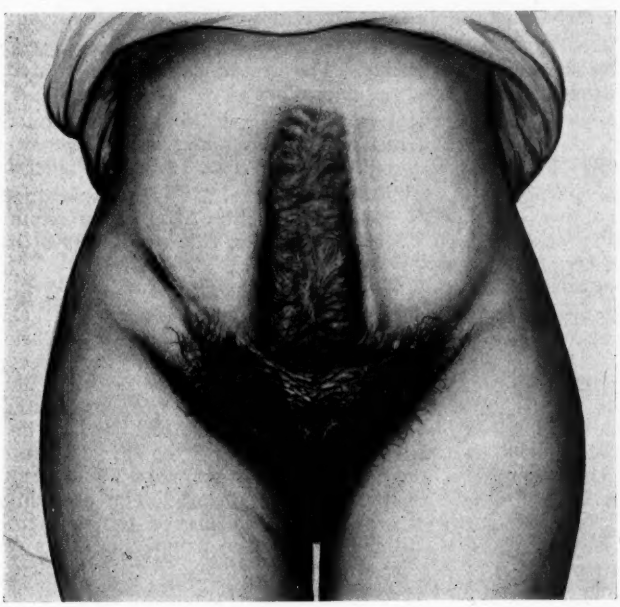


FIG. 94.—*Case* 5. V. K. Drawing made at age of 16, showing the wide abdominal scar and the final result of the plastic operations carried out for the removal of the bladder and the repair of the vulva. Just below the right anterior superior spine is the scar of the incision made for the evacuation of the extraperitoneal abscess which followed the transplantation of the second ureter. There is wide separation of the pubes.

was taken to make a sigmoidoscope examination. The anus was normal and was tightly contracted. The mucous membrane of the bowel looked normal but was moister than usual; no other notable change. Although it was possible to make a careful examination this time the ureteric orifices could not be found, though urine was obviously freely entering the bowel. The evacuation is, as a rule, a mixture of fæces and urine; sometimes clear urine is passed, and very occasionally a solid motion. She walks well without any waddle. The X-ray picture shows wide separation of the pubes.

Her family medical attendant was written to about the febrile attacks, and his reply of Jan. 11, 1928, is as follows: "This patient, before the ureters were implanted into the rectum, used to have acute attacks of abdominal pain. Situation of pain was indefinite—she was of course very young then—attacks used to last from one to two hours, and relief was obtained by placing her in a hot bath. Attacks came on about every two months. After ureters were implanted in rectum she had four or five 'attacks' at about four-monthly intervals. She was shivery and cold, had to be put to bed, and complained of *mild*, aching pain in her loins. There was tenderness over the kidney region. Poultices were applied to the loins and a diaphoretic mixture given. In three to four days she was quite well."

Summary.—Case of ectopia vesicæ in the female, under observation from birth to the age of 6 years, when operation was carried out. Transplantation of ureters into recto-sigmoid in two stages at an interval of three weeks. Perinephritic abscess opened during convalescence. In December, 1927, ten years after operation, the patient was 16 years old. She weighed 8 st. 9 lb., and was 5 ft. in height. She was well in every way and had perfect rectal function and control.

(NOTE.—In October, 1928, this patient had an unusually bad pain on the right side. X rays disclosed a renal calculus.)

***Case* 6.—Ectopia vesicæ. Transplantation of ureters into recto-sigmoid. Death from peritonitis.**

J. T., male, age 13. (Reg. Nos. 11980–11981.)

HISTORY.—This patient was admitted on March 4, 1919, with ectopia vesicæ, with all its discomforts. The boy was in good general condition. No previous operations.

OPERATION, March 14, 1919.—Median incision. Left ureter exposed and transplanted into the sigmoid by the method of Stiles. The ureter was greatly dilated and thin-walled. A portion of the corresponding vas was excised.

PROGRESS.—After operation the patient had a mild attack of pneumonia. He also suffered from very slight diarrhœa, but urine was soon passed per rectum at volition of the patient. By May 13 he was very well; weight 5 st. 11 lb. 7 oz., height 5 ft. 2½ in.

SECOND OPERATION, May 16, 1919.—The right ureter was transplanted into the sigmoid; it was dilated and thin-walled like its fellow. The site of the left anastomosis was obscured by adhesions, but it was observed that the bowel at this point was a little narrowed. A portion of the corresponding vas was also excised.

PROGRESS.—The patient stood the operation splendidly, and was quite well the next morning. The same afternoon blood was noticed in the evacuation. On the second day the patient was not so well and began to vomit a large quantity of dark green fluid. By the third day the boy was very ill. There was frequent vomiting, he complained of pain in the abdomen and on defæcation, and there was some rectal incontinence. There had been some more blood in the evacuation and some bleeding from the wound. On the fourth day the patient had less discomfort, was quiet and free from pain. The temperature was normal, but the pulse was 120–130 and very small and feeble. In the early morning he looked very ill, with sunken face, black nostrils, and cyanosis. The tongue was moist and only slightly coated. There was no distension of the abdomen and no tenderness either in front or in the loins. He suffered from rectal incontinence, but on introducing a catheter through the sphincter about 4 oz. of highly alkaline urine and fæces escaped. Catheter left *in situ* for drainage. At night he was much worse, frequently sick and with a very feeble pulse. Death occurred on the fifth day after operation.

POST-MORTEM EXAMINATION.—An autopsy disclosed general peritonitis, apparently originating in the neighbourhood of the right ureter, which had been transplanted last. A closer examination showed that the ureter had been penetrated by the fixation sutures so that there must have been leakage of urine into the peritoneum. Unfortunately there is no record of the condition of the kidneys.

Case 7.—**Complete epispadias with incontinence. Transplantation of ureters into recto-sigmoid in two stages, at one and a half years interval. Recovery.**

W. P., male, age 5. (Reg. Nos. 13713 and 13714.)

HISTORY.—This patient was an only child. He was a small delicate baby who only survived owing to the devoted care of an excellent mother. During the first twelve months of his life he was three times in hospital in Leeds, but no operation was carried out. The child was under observation for some time, and as the parents were most anxious to have the operation carried out the first stage was performed at the age of 5½ years, despite the fact that he was small for his age, fair-haired, and delicate.

OPERATION, Aug. 16, 1918.—General anæsthesia. Median incision below and to the right of the umbilicus. The parts were very small, and the great tendency of the intestine to escape from the abdomen was very troublesome. The right ureter was exposed low down and divided, the distal portion being ligatured. Anastomosis into the rectum was carried out by the method of Stiles, about one inch of the ureter being buried in the wall of the gut. The vas on either side was exposed from the pelvis, and divided. The abdominal wall was closed by means of figure-of-eight silkworm sutures. No drainage was provided. A large rubber catheter was passed into the bladder to prevent, if possible, the urine from flowing over the abdominal wound. The operation took about an hour and the boy was rather shocked towards the end.

PROGRESS.—The day after operation the condition was satisfactory. On the 18th and 19th the patient was not so well, being very restless and vomiting frequently. By the 21st the patient had not had the bowels moved, so 1 gr. of calomel was given at night and another on the following morning. That day there was some movement of his bowels. He was still very restless, but there was no vomiting. On the 23rd, just a week after operation, the patient was obviously very ill. It was considered that he had developed some pelvic peritonitis, either the result of retroperitoneal suppuration or of some sloughing of the ureterocolic anastomosis. Under a minimum of anæsthesia the lower sutures in the abdominal wall were removed. As soon as the peritoneal cavity was reached there was a rush of offensive urine followed by pus. Drainage was provided and the boy steadily improved in every way. Pus and urine continued to be discharged from the abdominal wound, but in spite of this he did pass some urine per rectum and he was soon well enough to return home.

After leaving hospital the sinus closed in a few days, and the boy steadily and slowly improved though he continued small and delicate. In February, 1920, he weighed only 2 st. 7 lb. 3 oz. With a view to carrying out the second stage the patient was readmitted in May, 1920. He was still very small for his age, weighing 2 st. 8 lb. 12 oz., and looking frail and delicate.

SECOND OPERATION, May 22, 1920.—The abdomen was re-opened in the mid-line and loops of small bowel were found covered with thin omental adhesions and adherent to the right side of the pelvis, thus obscuring the site of the old anastomosis. The pelvic colon was separated from the pelvic wall and drawn towards the right. The left ureter was then divided about the level of the upper end of the internal iliac artery, and was implanted into the sigmoid by the method of Stiles. There was no tension, the ureter lying comfortably against the bowel wall. This time a small rubber tube was brought from the region of the anastomosis and by a retroperitoneal route through an independent puncture in the left iliac fossa. The abdomen was again closed by figure-of-eight sutures. A large catheter was left in the rectum.

PROGRESS.—For the first three days the condition gave no cause for anxiety, but on the fourth day it was noticed that the patient had developed a rash, slightly papular and with a definite inflammatory edge; there was itching and slight rise of temperature. It was present on the arms, legs, and feet, and a large patch appeared on the forehead. In a couple of days the rash had almost gone, leaving a slight, coppery pigmentation still visible on the limbs. By this time the patient looked very well. The rectal tube was removed and was followed by a good movement of the bowels. By the 29th the rash had completely gone, and the drainage tube was removed from the abdominal wound, which was healthy except for slight irritation round the second top stitch. As far as could be ascertained the boy had rectal incontinence.

On the 31st, that is nine days after the operation, the patient was fairly well but complained of a little pain in the left side and had some temperature and was flushed. Until this he had taken food fairly well, but now he was a little out of sorts and very thirsty. On the 10th day following operation there was some slight urinary leakage from the site of the abdominal drainage tube, and this continued for a week, when it stopped spontaneously. During the next day or two the temperature was up to 101° and the boy was chesty. On June 7 it was noted that the patient had been much better during the previous three days. By June 10 he was well in himself and had a good appetite. Rectal continence was much improved, and he now never wetted the bed during the day, and only about twice at night.

In November, 1920, the report was very satisfactory. The general health was much improved; he took his food well and always had a good appetite. He was attending a small private school and playing games with the other children. The rectum was emptied about six times during the day and about twice or thrice at night. The boy emptied the rectum when he went to bed about 9 o'clock, and when the parents retired at 11 o'clock he was wakened for this purpose, and again at about 3 a.m. If the intervals were longer than this there might be a slight accident, but not always. At 5 a.m. or thereabouts the boy awakened himself and emptied the bowel, after which he slept in comfort until 8 o'clock when he rose. The parents were delighted with the result of the operation.

In July, 1924, the boy was looking better than ever before. He still had to empty the rectum about twice each night. There was some weakness and a tendency to ventral hernia about the centre of the abdominal scar. In August, 1925, the patient was 12 years of age. The mother reported that for two or three months he had not been so well. Every few days he was seedy and not so lively as usual. There was no shivering or vomiting, but he complained of tenderness in the left loin. When seen he looked very well and was quite plump and a good colour, but there was slight tenderness in the left kidney region, though the organ was not found to be enlarged. Rectal continence was good and the sphincter competent. He was given a teaspoonful of potassium citrate every twenty-four hours, after which the symptoms rapidly disappeared and did not recur. Concerning these attacks, Dr. Stitch reported as follows: "This boy had two febrile attacks with pains in loins and malaise. In the first attack we attended him from May 13, 1925, until May 20. In the second we attended from Aug. 6 to 19, 1925. He has been quite well since so far as we know, and I often see him playing games with other boys, though he is rather quieter and less boisterous than the average boy. I think the latter characteristic is due to a studious nature which has been fostered by his disability." In February, 1926, the boy reported that he was better than ever before.

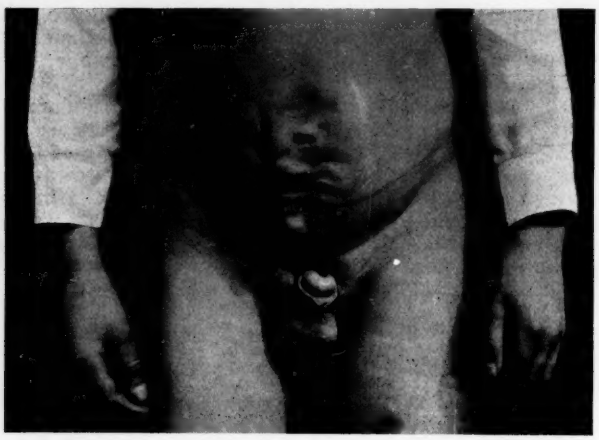


FIG. 95.—*Case* 7. W. P. Photographs at 15 years of age, 7 years after operation. Show good nutrition and development.

On Dec. 16, 1927, seven years after the last operation, he came up for inspection. He was then nearly 15, and was very well in every way and looked well nourished and healthy (*Fig.* 95). He had finished school, having reached the 6th standard, and was attending a Commercial College. He weighed 4 st. $2\frac{3}{4}$ lb. and measured 4 ft. $2\frac{3}{4}$ in. in height. The daily routine was much as follows: At 8.30 he rises, empties bowel, and has breakfast. Afterwards comes to Newcastle by train, goes to college, where he sits at his work until 12.45, when he goes to a café, ten minutes' walk, for dinner, and then for the first time since breakfast he empties the bowel. Occasionally during the course of the morning he does go to the lavatory. After dinner he returns to college, where he remains

till 4.15, when he goes a train journey of twelve minutes, then walks home—which takes him five minutes—has tea, and then, or just before, goes to the lavatory again. After tea he goes out to play for a couple of hours and takes part in any game that is going—football, cricket, etc. Afterwards does preparation until supper at 9, after which he evacuates the bowel. He goes to bed about 10, and awakens about thrice in the night to empty the bowel. He states that he can pass flatus independently of emptying the rectum and that there is never an accident. The evacuation is always urine and liquid fæces intimately mixed. Never voids a solid motion. The anus and sphincter are quite normal. Sigmoidoscope examination was not made as the boy was rather nervous about it. The evacuation contained 3 gr. of urea to the ounce. He sometimes gets pain in the left side, but only very seldom—about twice in the last two years. No tenderness or enlargement of the left kidney—i.e., where he has had the pain. The testicles are descended and well developed. X rays show a normal-looking pelvis except that the pubic bones are separated to the extent of 1½ in.

Summary.—Case of complete epispadias with total incontinence of urine in a very delicate type of boy. Operation at 5 years and 6½ years respectively. Long interval on account of pelvic infection with urinary fistula after the first stage. Since second operation has steadily improved in health and has been able to attend school, where he has done very well. Three years after operation had some attacks of renal infection which readily yielded to treatment. In December, 1927, seven years after operation, he was nearly 15 years of age, in splendid health, and with perfect rectal function and control.

Case 8.—**Total epispadias with incontinence. Transplantation of one ureter into rectum. Recovery.**

N. B., male, age 13. (Reg. No. 13489.)

History.—Patient complains that he cannot hold his water at all, and that "he wets his bed and his trousers." Has had this trouble ever since he was born. He states that he had pneumonia when he was 10 years old.

On Examination.—Condition of epispadias with dorsal cleft down to pubes, the mucous membrane being exposed in the entire penile portion of the urethra. A forefinger can be introduced easily into the bladder. The patient has almost complete incontinence when up and about, but not marked when lying in bed. His clothes were constantly wet, smelly, and encrusted with phosphates. He was undersized, very anæmic, precocious, and apparently in good general health. No obvious cause for the anæmia was detected. For a week he was kept under observation, and as he appeared to be all right it was decided to operate.

Fig. 96. *Case* 8. N. B. At 13 years of age he was completely incontinent. One ureter was implanted into the recto-sigmoid. Since that operation he has acquired continence and urinary control. Since this photograph was taken the local deformity has been repaired, and he now only presents a slightly bifid glans.

Operation, Jan. 22, 1921.—Median incision above and below the umbilicus. The left ureter was exposed above the brim of the pelvis and divided, the proximal end being transplanted into the upper rectum by the method of Stiles. There was a small hæmatoma below the anastomosis which was opened and the clot turned out. A fine rubber tube was brought through a separate opening from the site of the anastomosis.

Progress.—Jan. 25: No abdominal symptoms. Had a high temperature and quick pulse and was very tender over the left kidney. Jan. 31: The boy was much better; he still had a fitful high temperature, but was not tender in the left loin. Bad cough. Feb. 1:

Patient's temperature continued; tube removed. Feb. 6: Wound healed; never been any leakage. Feb. 7: Definite tubular breathing and increased vocal resonance in the upper part of his left lower lobe. Dr. W. E. Hume reported massive collapse of the base of the left lung. March 19: Boy generally very well, up and about and active. The incontinence not nearly as bad as before, and could fairly be described as halved. The left chest had not yet recovered; there was still some collapse, and at the apex there was an area of localized crepitations, which Dr. Hume thought was evidence of tuberculosis. The spleen was palpable. Further operation was postponed.

Jan. 8, 1928: This was the first time this boy had been seen or heard of since the operation. He is now big and strong, age 19 years, weighs 8 st. 9 lb. and is 5 ft. 4½ in. high. Plays football vigorously. He has a big appetite and eats one stone of bread a week. Says that now and for some years he has not suffered from incontinence. He has control over the act of micturition and passes urine like other men (his father says the water splutters about). The lad's statement was borne out by the fact that his shirt and other clothing were quite dry, and by his mother, who stated that his bed was never wet. Only empties rectum four times daily. Evacuation is always liquid. Penis very large and testicles well developed (*Fig.* 96). Recently had bad attack of pneumonia. The urine passed per urethram contains 1·8 per cent of urea; that per rectum 0·5 per cent. When examined with the sigmoidoscope the rectum looked normal; there was very little urine in the lower part, but it welled into the instrument from above the folds of Houston. The ureteric orifice could not be found.

A plastic operation was carried out for the closure of the urethra. This was satisfactory except for the region of the glans, where there was a little loss of tissue by sloughing. The patient was not in the least upset by this interference, and showed no evidence of renal abnormality while in the hospital.

Cases 9 and 15.—**Ectopia vesicæ. Transplantation of ureters by Peters' method in one stage. Good recovery. Further operation for removal of mucous membrane of bladder. Transplantation of left ureter by method of Stiles. Recovery.**

T. L., male, age 4 years 2 months. (Reg. Nos. 14199–17328.)

History.—The boy, the second child of healthy parents, was born with complete ectopia vesicæ. He was carefully looked after as a baby and throve well. When admitted to hospital he was found to be well developed in every way except for the local deformity. Wide separation of the pubes was very striking. There was no evidence of renal sepsis. The mucous membrane of the bladder presented an extraordinary villous condition, making it look like a tumour; this condition only effected the parts above the trigone; the latter was not involved, but was obscured by the overgrowth of villous processes from above. It was decided to carry out the Peters operation as being less dangerous in a child of this age.

Operation, Nov. 22, 1921.—General anæsthesia, open ether. The ureters were found with ease, and a No. 6 Jaques catheter, with the end cut off, was passed into each. Urine flowed freely from the left side, but none came from the right. The separation of the ureters from the bladder wall was difficult because the parts were overhung by the villous processes, and because of the free bleeding. Eventually about 1½ in. of each ureter were separated with a rosette of bladder wall round the orifice. The catheters were fixed to either ureter with a fine catgut suture. With a finger in the rectum the anterior wall of the latter was pushed forward and was divided transversely without opening the peritoneum. The ends of the ureters, with their catheters, were then turned into the rectum, the catheters being brought out of the anus. The incision in the rectal wall was drawn together with two or three interrupted catgut stitches, the ureters traversing the bowel at either extremity of the transverse incision. The operation took about half an hour and was well borne.

Progress.—This was uninterrupted. There were never any bad symptoms, and nothing to suggest renal infection. The bowels moved naturally, and there was no fæcal leak from the incision in the posterior bladder wall. There was never any flow of urine from the catheter on the right side, and on the 27th it came out of its own accord; on the 28th its fellow, which had discharged freely, also slipped out. The child continued to do well, and left hospital on Dec. 13.

From the first this patient began to develop rectal control, but it was not complete, and he was always more or less wet at night. By January, 1922, his mother was able to report "the control in the daytime is now growing quite good, and there is no need to take any precautions other than continual watching and reminding. At times he can hold for three hours, his best days, at others every hour, but during the night we have not been so successful. Nevertheless, we do feel that he is making good progress in this respect. His appetite continues good, and there has been no sickness, but the boy seems very frail."

This patient was brought to see me on Oct. 19, 1922, because his father thought he

dragged the right leg more than he ought to do. I found just a little weakness of the leg, but nothing to cause the slightest concern. The boy appeared to me to be perfectly well, and his mother tells me that he sleeps and eats quite naturally. In the daytime he has perfect control. Not only so, but he can, if necessary, wait as long as twenty minutes in spite of an urgent desire to clear the bowel. The fæces and urine are sometimes mixed, but often passed alternately. At night time there is occasionally a little incontinence, but it is not bad. About every six weeks he gets some sort of attack, which may be associated with renal infection, but his mother tells me that he is never tender in the loins, and that he never vomits. Both the nurse and the mother informed me that when he has one of these so-called 'attacks' they notice a peculiar smell which is at times offensive. The exposed mucous membrane of the bladder gives him no trouble, and it was not proposed at the moment to interfere with it.

In November, 1923, the attacks were more troublesome, and were described as follows by his nurse: "Sickness, limp and tired, loss of appetite, temperature high, rapid pulse, dark rings round eyes, face pale; occurring every ten days to a fortnight. Complains of pain in left hip; always drags right foot. Sickness immediately after food, and is always hungry after sickness. Passes undigested food in motions; colour yellow and sometimes greyish yellow. Urine sometimes highly coloured and rather offensive. Granulations (i.e., exposed bladder mucous membrane) sometimes very inflamed and sometimes almost white. Incontinent when sleeping during attacks, but at other times perfectly all right. Rectum emptied about five times each day. There is some offensive discharge from the bladder area." When seen he was looking thin and white, but the general nutrition was fair. Walks rather badly owing to wide pelvis. In December, 1923, he had rather a bad attack, but he soon picked up, gained weight, and was in wonderful spirits. During 1924 he had several attacks, but in July he was a good deal better, and weighed 3 st. 7 lb. By January, 1925, he was very fit on the whole, though still slightly feverish at times. Has had much better control during the last few weeks. He was seen in February, 1925, looking very well, though nervous.

Later, in September, 1925, it was decided to remove the mucous membrane of the bladder. For this purpose he had a general anæsthetic. The operation (Reg. No. 16910) took three-quarters of an hour. It was borne well, and there were no unusual features as far as the anæsthetic was concerned. The boy did not empty the rectum while going under the anæsthetic, but 2½ oz. of urine were drawn off at the beginning of the operation and 1½ oz. at the end—i.e., the latter had accumulated during three-quarters of an hour. This specimen was clear except for masses of floating mucus. It smelt strongly ammoniacal and was very alkaline to litmus paper; specific gravity 1012; only a faint trace of albumin; no sugar; urea 1·3 per cent. Bacteriologically the prevailing organisms were streptococci and bacilli of Morgan No. 1 type.

The skin about the anus was natural in appearance, and the sphincter as judged by resistance to the finger, and the rectum as seen by the sigmoidoscope, seemed normal. The latter was certainly not unduly dilated. The ureters were felt on the anterior wall 1½ in. from the anus. They were like two raised nodules in the midst, or rather on the surface, of an area of firm scar tissue. Seen with the sigmoidoscope they were paler than the mucous membrane of the rectum and just like two rosettes, and from time to time urine was seen to be ejected from the slit-like orifice on the summit of the left.

At this operation tenotomy of the right tendo Achillis was first carried out, and this was followed by excision of the mucous membrane of the bladder. The latter step was not difficult, but several vessels required ligature and bleeding obscured the field. The recti muscles could not be drawn together and the skin only to a slight extent. The testicles were noted to be both in the scrotum.

Progress.—The boy did not appear to be upset by this interference, but when the gauze was removed from the bladder area it was noticed to be wet with urine, and it was soon obvious that there was a leak, a communication having been established with the rectum. An attempt was made to close this by suture on Oct. 10, the patient being under an anæsthetic for about twenty minutes. After this interference he had pyrexia, the temperature rising to 103°, and he was upset, but there were no symptoms to cause alarm.

The leakage continued, and on Nov. 4 another operation was carried out. A hole was found leading into the rectum which would admit the tip of the little finger, and into this hole the left ureter was prolapsed. Its open mouth was seen like a rosette at the upper margin—i.e., external aspect—of the hole, and from this urine freely escaped. The ureter was drawn into the rectum and fixed there by sutures, the hole in the rectum being drawn together. The closure looked satisfactory, but on Nov. 8 there was again obvious leakage.

On Nov. 18, under anæsthesia, a No. 6 rubber catheter was passed into the orifice of the left ureter, which had again prolapsed into the aperture, and about two drachms of almost pure pus were drawn off. The catheter was brought out of the anus and the hole in the rectum closed. The kidney was irrigated daily through the catheter. There was very

little reaction, and the boy continued to take food, etc., as usual. When the catheter came out at the end of a week it was obvious that the fistula was not healed, and the urinary leakage recurred.

In March, 1926, the bladder mucous membrane round the fistula was touched with the electric cautery. From this time onwards practically all the urine escaped from the fistula, and from time to time there was some fæcal discharge. He required to be changed two-hourly. His general condition remained quite satisfactory. In July, 1926, it was decided to transplant the left ureter into the sigmoid, the boy being in very good condition except for the urinary fistula.

Operation, June 12, 1926 (Reg. No. 17328).—The patient was passing an abundance of urine which could not be measured. Samples contained 10 gr. of urea to the ounce. Blood-urea was slightly increased, 36 mgrm. per 100 c.c., indicating some renal inefficiency. General anæsthesia, Trendelenburg position. The left ureter was found to be enormously distended, and looked like a piece of small intestine. An attempt was made to implant it into the bowel by the method of Stiles, but it could not be buried in the gut without using an inordinate amount of the latter for the 'tuck in'. It was, therefore, only buried at the point of anastomosis, and the latter was protected by stitching neighbouring appendices epiploicæ over the site. A rubber tube was brought from the neighbourhood of the anastomosis out through the parietal wound. Both kidneys were felt to be small, and the right ureter was about the same size as the left, but it was not interferred with. The incision was closed with figure-of-eight silkworm. The operation took just under one hour. The boy stood the interference very well, and suffered no immediate ill effects. On the 8th day he had a definite kidney reaction, with temperature up to 101°, sickness, and tenderness in the left loin. This soon passed off and he was able to leave hospital three weeks after the operation.

Unfortunately the urinary leakage continued much as before, and from time to time there was an escape of fæcal matter from the bladder fistula. By the early part of September his general condition was excellent, he was very active, and was taking his food well, though the local condition was very little altered. About the middle of this month he had a very severe renal attack, which came on quite suddenly and greatly alarmed his parents and medical man. It began with a rigor, the temperature running up to 103° with corresponding quick pulse. He was sickly, restless, and very thirsty. The urine was thick and very offensive, and contained much pus. He also had diarrhœa, and was very tender in the left loin. By the end of the month his condition was apparently normal again, but he had lost a good deal of weight and was white and pinched. This was the most severe attack from which he had ever suffered.

By December, 1926, he was about himself again; he had a good appetite and was regaining strength. He rides a bicycle, and has a companion with whom he plays and does lessons. There was perhaps a little less urinary leakage. The parents were averse to any further operation at that time, and in October, 1927, he was fitted with a urinal which kept him more comfortable during the day. Generally he was surprisingly fit and well.

Case 10.—**Total epispadias with incontinence. Transplatation of both ureters in two stages. Recovery. Intestinal obstruction three years later. Death from peritonitis.**

J. F., male, age 10½ years at the time of operation. (Reg. No. 14482.)

History.—The patient was admitted to the hospital on March 19, 1922. He had suffered from incontinence of urine, with all its disagreeable consequences, since birth. His education had been very seriously retarded. Apart from an attack of measles at the age of four years, and of scarlatina some few months prior to admission, there was nothing of importance in the past history. He was, however, said to have 'never been very strong'.

On Examination.—The general health appeared to be fairly good. Locally there was a condition of complete epispadias, and the resulting incontinence had caused excoriation of the skin over the lower abdomen and scrotum. The child's general health and the fact that he had successfully weathered the storms of the acute exanthemata showed a good resistance.

First Operation, March 22, 1922.—General anæsthesia. Mid-line incision. The left ureter was approached by the transperitoneal route, mobilized, and after division low in the pelvis was transplanted into the sigmoid colon after the manner recommended by Stiles. A small rubber drainage tube was placed down to the region of the anastomosis; in addition a short tube was passed through the anus into the rectum to prevent distension. The child stood the immediate effect of the operation very well. It was followed by a fairly vigorous renal reaction as evidenced by the temperature, which reached its highest point, 100·8°, on April 4, with tenderness over the left kidney.

Second Operation, April 22, 1922.—General anæsthesia was again employed and the

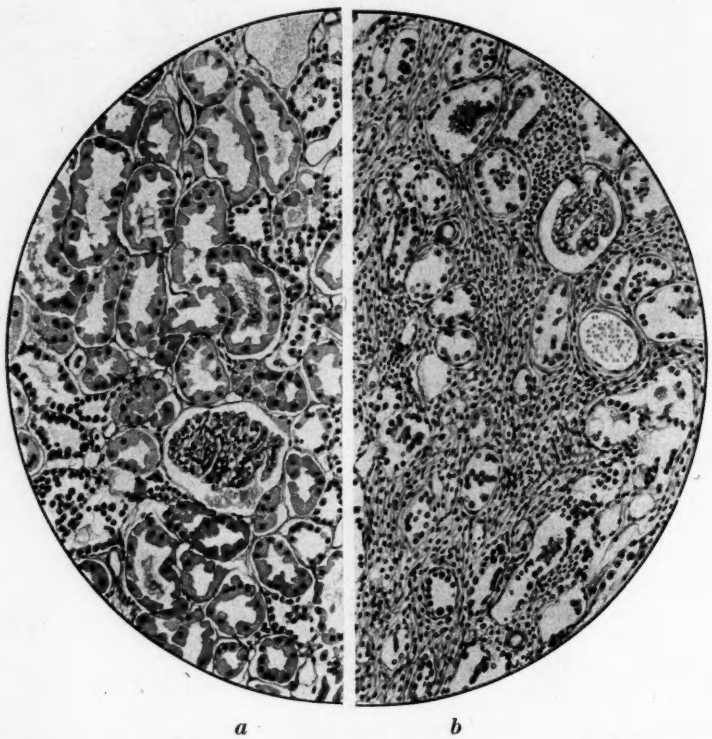
old incision re-opened. The right ureter was implanted by a similar procedure into the sigmoid, drainage being employed as before. In addition it was observed that: (1) The previous anastomosis was well protected by the parietal peritoneum having been sutured over it; (2) The left ureter could be felt in the bowel wall as a thickening, reminiscent of rectal polypus; (3) The rectum appeared to be more distended and hypertrophied than at the previous operation; (4) On opening the bowel after the application of the clamp, clear urine escaped. A good recovery was made from this operation, but a definite attack of renal infection again occurred, with some night fever up to 100·4°, which continued until May 1.

FIG. 97.—*Case* 10. J. F. The parts obtained after death from this patient, who died of intestinal obstruction 3 years and 3 months after implantation of both ureters. Intermediate health had been excellent. The right ureter is nearest the anus. The whole rectum is dilated, its wall is a little hypertrophied and the mucous membrane is covered with an inflammatory exudate which gives it a roughened shaggy appearance. Above the level of the ureteric orifices the surface appears normal.

On May 9, 25 oz. of urine were being passed from the rectum per diem. This urine had a specific gravity of 1010, a thick, dirty yellow appearance, a ropy deposit, an ammoniacal smell, and an alkaline reaction. On May 11, the entry in the hospital notes reads thus: "The patient is bright and happy. He passes urine per rectum with perfect continence about four times a day, and his bowels move comfortably about three times a day. The motion is a fluid one. His temperature and pulse are normal. He sleeps and eats well, and states that he feels better than ever he has done before. His abdominal wound is

healed perfectly and there is no sign of skin irritation left over the lower abdomen and scrotum." Urine from the rectum contained 4½ gr. of urea per ounce, i.e., 1·4 per cent. On May 16 he was discharged.

He remained perfectly well until May, 1925—three years later—when he was re-admitted with a history that during the previous twenty-four hours he had been suffering from recurring attacks of colic. Up to this time he had been attending school regularly, playing with the other boys, and taking food well—in fact, he appeared in every way normal. When seen in the hospital the boy was found to be in very good condition, and nothing abnormal was discovered on physical examination. The possibility of the attacks being renal in origin was at first considered, but the boy appeared to be perfectly well, the temperature was not elevated, there was no tenderness in the loins, and no palpable enlargement of either kidney. After two days, there being no recurrence of the pain, he was allowed to go home. A few days later, however, he was re-admitted, looking very ill and with evident signs of intestinal obstruction, with copious fæculent vomiting. The abdomen was opened by a junior colleague and the condition found to be an acute obstruction of the small intestine due to a band in association with tuberculous mesenteric glands.



a *b*

FIG. 98.—Microscopic sections of (*a*) left kidney and (*b*) right kidney. (× 86.)

It was necessary to make a lateral anastomosis. At the end of the operation there was a marked degree of collapse, but this was speedily overcome and for a couple of days recovery seemed assured. At the end of this time symptoms of peritonitis developed and the condition rapidly progressed, death occurring on the fifth day.

POST-MORTEM EXAMINATION.—There was a suppurative peritonitis binding the coils of intestine together. Some of the sutures at the anastomosis had given way and fæcal matter had escaped. The mesenteric glands were distinctly enlarged and caseous, some being definitely calcareous.

An examination of the recto-uro-genital organs resulted as follows (*Fig.* 97):—

The *rectum* was distended and its muscle definitely hypertrophied. The mucosa below the level of the ureteric orifices was coated by a shaggy exudate, and microscopically this region was found to be the seat of a mild catarrhal inflammation, whilst above this level the mucous membrane was smooth and appeared healthy both on naked-eye and microscopic examination. This slight degree of catarrhal inflammation could probably be

explained by the irritation consequent on ammoniacal decomposition of the urine. The right ureteric orifice was patulous, its mucosa having prolapsed, giving it a button-like appearance. Its wall showed a similar inflammatory change to that seen in the neighbouring rectal mucosa. The left ureteric orifice was very difficult to find, and was represented by a mere slit through which only a fine bristle could be passed, contrasting with its fellow, which admitted with ease a glass rod of much greater magnitude. The orifice of the left ureter could only be demonstrated by injecting fluid into the ureter above and searching for the issuing stream.

The *right kidney* was markedly shrunken and its surface deeply scarred. On section the organ consisted mainly of the dilated pelvis and calices. The condition was an advanced pyelonephritis. Microscopic examination (*Fig.* 98 *a*) of such renal tissue as remained showed extensive fibrosis, hyaline changes, and round-cell infiltration in the glomerular region. The tubules showed cloudy swelling. Areas of necrosis with accumulation of polymorphonuclears were also present, and in these there were a few bacteria.

The *left kidney* was of normal size. Its surface was also somewhat scarred. In the section some of the pyramids were much darker than the cortex. The cortex was swollen and the vascular markings stood out prominently. The pelvis and calices were slightly distended, the former merging imperceptibly with the ureter. Histologically (*Fig.* 98 *b*), the cortex showed areas in which some of the glomeruli were fibrosed, others showed slight lobulation, and in addition there was a round-celled infiltration. The tubules showed little change apart from cloudy swelling. The areas of fibrosis represented healing after a previous acute nephritis, probably a ' flare up ' after the transplantation operation. The appearances indicated the presence of a subacute inflammation of the kidney probably of the nature of an ascending pyelonephritis. A considerable number of fields exhibited relatively normal renal tissue. It is possible that the areas of necrosis containing bacilli, etc., seen in the right kidney represented a terminal pyæmic process, a consequence of the septic peritonitis.

The *ureters* when opened contained a quantity of purulent fluid. Both of them were dilated, but the wall of the right was the thicker. The right ureter was also shorter and more tortuous, and about its middle there was a definite annular narrowing. Histologically there was evidence of ureteric infection.

Summary.—A case of total epispadias with incontinence. Operation at 10½ years of age. Transplantation of both ureters into recto-sigmoid at an interval of a month. Good recovery, and health with normal rectal function and control for three years. Death from peritonitis following an operation for acute intestinal obstruction. Right kidney in condition of pyonephrosis, the left showing evidence of recovered pyelonephritis.

Case 11.—**Ectopia vesicæ. Transplantation of one ureter. Death from peritonitis.**

E. H., female, age 2 years 7 months. (Reg. No. 15301.)

History.—This baby was a healthy child with typical complete ectopia. It had been under observation since it was a few days old and had thriven very well.

Operation, April 7, 1923.—Combined spinal and general anæsthesia. Trendelenburg posture. The intestine did not tend to prolapse. The left ureter was found very much dilated and full of urine; it vermiculated freely. Peritoneum over it divided and about 2 in. of ureter mobilized. It was divided just above the bladder, and the distal end was allowed to retract into the retroperitoneal space. During this stage some urine from the upper end of the dilated ureter escaped into the peritoneum. The anastomosis to the bowel was made by the method of Stiles, great care being taken not to compress the ureter, and not to perforate the wall with the fixation sutures. The big ureter took up a good deal of bowel for the tucking-in process, and rather narrowed it in consequence. A tube was brought from the site of anastomosis to the outside.

The child stood the operation well, and recovered from the immediate effects without incident, but afterwards she never appeared to be quite right. The day following the operation, and for several days, she vomited continuously and looked very ill. Death occurred on the ninth day.

Post-mortem Examination (notes very poor).—General peritonitis involving infracolic area of the peritoneal cavity. This appeared to come from the wound. The junction between the ureter and the colon was intact. The pelvis of the left kidney was dilated and filled with purulent urine. There was extreme pallor of the renal tissue, but no obvious pyelonephritis. On microscopic examination the capsule was found to be definitely thickened and there was a moderate degree of chronic venous congestion. Irregularly scattered throughout the cortex, but more particularly in between the collecting tubules, there was an inflammatory cellular infiltration, the cells in which were chiefly

of mononuclear type. There were a few foci of inflammatory change due to abscesses which were undergoing repair. The infection appeared to be of ascending type. The right kidney showed marked dilatation of pelvis and ureter, but without infection.

Summary.—Case of ectopia vesicæ in a healthy child of 2 years and 7 months. Death from peritonitis after transplantation of one ureter. The infection appeared to arise in the region of the abdominal incision. The kidney on the transplanted side showed very definite ascending pyelonephritis.

Case 12.—**Ectopia vesicæ. Transplantation of both ureters in two stages at three weeks interval. Recovery.**

J. P., male, age 10 at time of operation. (Reg. Nos. 16250–16251.)

History.—The patient was the second child of a family of three, the parents not being very robust. On admission he looked thin and weedy, but seemed healthy enough and took food well. Weight 3 st. 2 lb. 9 oz. The ectopia was complete but there was no hernia. The pubic bones were widely separated (*Fig.* 99).

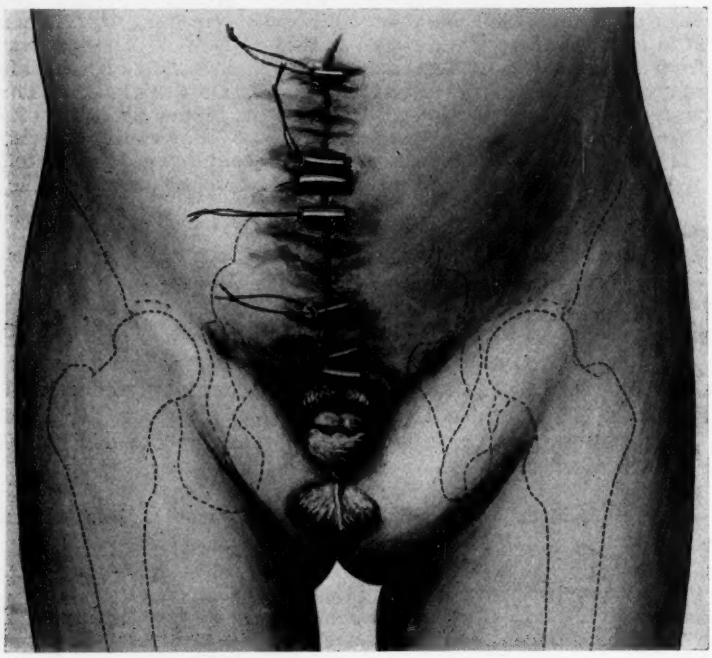


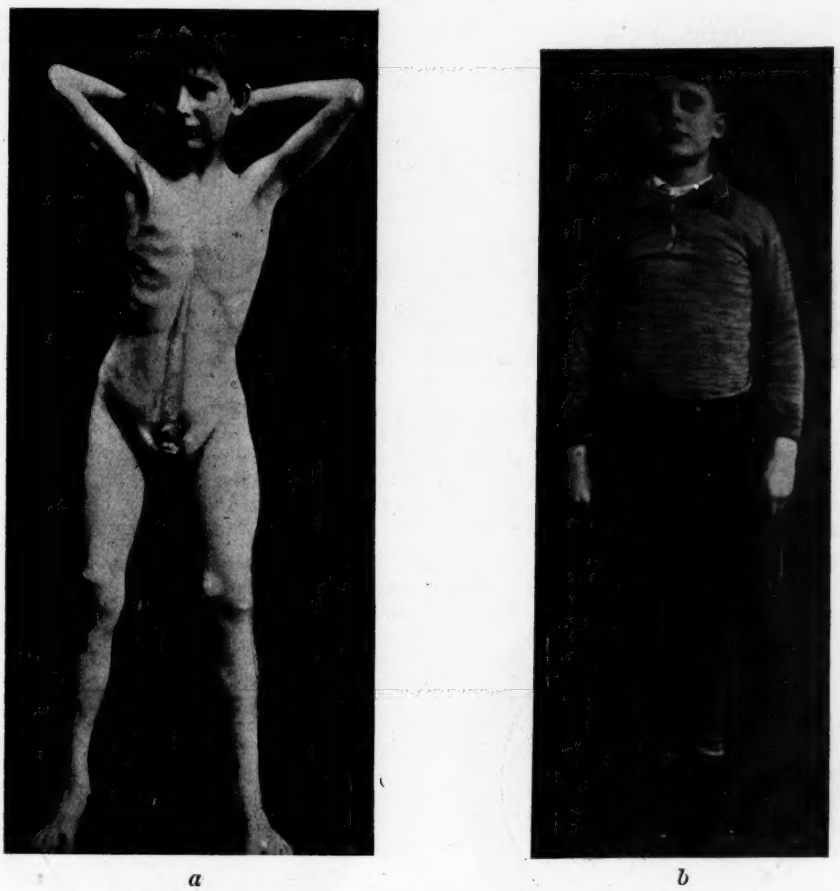
Fig. 99.—*Case* 12. J. P. Drawing made to scale (November, 1924) during convalescence from transplantation of the second ureter. The outline of the skiagram of the bony pelvis has been superimposed. In December, 1927, a further skiagram showed the same wide separation of the pubes.

First Operation, Oct. 7, 1924.—General anæsthesia. Mid-line incision. Trendelenburg posture. Left ureter first dealt with. It was ligatured and divided close to the bladder, and the lower end carbolized and allowed to retract. About 1½ in. of ureter were buried in the bowel by the method of Stiles, and the region of anastomosis was fixed to the edge of the pelvic peritoneum by suture. A small drainage tube was brought from the neighbourhood of the anastomosis through the parietal incision. The operation took about one hour and was well borne.

Progress.—This patient was very well, and there were no special symptoms, and certainly no cause for anxiety, until the morning of Oct. 9, i.e., two days after the operation. On this day he became suddenly ill, there was severe collapse with pale bluish lips, cold, clammy surface, and feeble pulse. The ward sister, an experienced nurse, thought that he might be going to die, and the house surgeon feared some internal hæmorrhage. The boy did not vomit, but felt sick. There was no complaint of pain. When seen by the author a diagnosis of left renal infection was made. The wound was dressed, and a

small tag of omentum was found prolapsed through the upper end, but this was not recent. The attack soon passed off and his condition steadily improved. By the 13th he was taking abundant liquid nourishment. Citrate of potassium in 15-gr. doses was given thrice daily. At first the emptying of the rectum was involuntary, but by this date he was developing control and asked for the bed-pan frequently. There was never any leakage from the abdominal drainage tube, and it was removed on the twelfth day. By the 26th the boy was very well in every way.

SECOND OPERATION, Oct. 28.—General anæsthesia. Abdominal incision re-opened. There were some few adhesions to the back of the incision. The lowest part of the sigmoid was closely adherent to the wall of the pelvis, covering the site of the first anastomosis and obscuring the ureter. The sigmoid above was quite free and normal. The rectum was



a *b*

FIG. 100.—*Case* 12. J. P. Shows general development and nutrition (*a*) before and (*b*) after operation.

much dilated, almost filling the true pelvis, and when later it was incised it was found to contain a good deal of liquid fæces. The right ureter was implanted into the bowel at a higher level by the same method, and the site of the anastomosis was fixed to the pelvic wall. The appendix, which was unusually long, was removed. Again a drainage tube was brought from the site of the anastomosis. The parietes were carefully sutured, and a large catheter was introduced into the rectum through the anus, through which liquid fæces at once escaped. The boy stood the operation well, and made an entirely uninterrupted recovery without any symptoms to suggest infection of the right kidney. From the time of admission until the day before the second operation the temperature was persistently subnormal. The day after the second operation it rose to 100° and remained about the red line, or just above it, for a week. The boy left hospital on Nov. 15 in very good condition and with improving rectal tolerance.

On Feb. 14, 1925, the patient was seen again. He was very well, but still looked thin and delicate. His mother stated that the bowels were moved many times daily, that he sometimes wet the bed at night, but that the condition was steadily improving. In May, 1926, he was seen once more, and appeared to be in very good health, though still rather thin. Owing to some misunderstanding he had been refused admission to school, but as a result of negotiation with the Education Authority this was rectified and he was allowed to attend. A year later the schoolmaster reported that he was doing well and that he was quite of average intelligence. His condition in no way interfered with his attendance.

FIG. 101.—*Case* 12. J. P. Skiagram of pelvis, December, 1927. The distance between the pubes is $2\frac{11}{16}$ in., and between the ischial spines $2\frac{7}{16}$ in. This boy has a distinctive gait, but plays games with his fellows and does not complain of weakness.

On Dec. 12, 1927, the boy came up for inspection. He had greatly improved in every way, and looked plump and well. He weighed 3 st. $12\frac{1}{2}$ lb. and was 4 ft. $4\frac{3}{4}$ in. in height (*Fig.* 100*b*). His mother stated that he had never ailed since he went home, and especially there have been no feverish attacks. He takes food well, is happy and cheerful, and goes to school regularly, playing games just like other boys. He walks characteristically with his feet a little apart, but there is no waddle. X rays show a well-

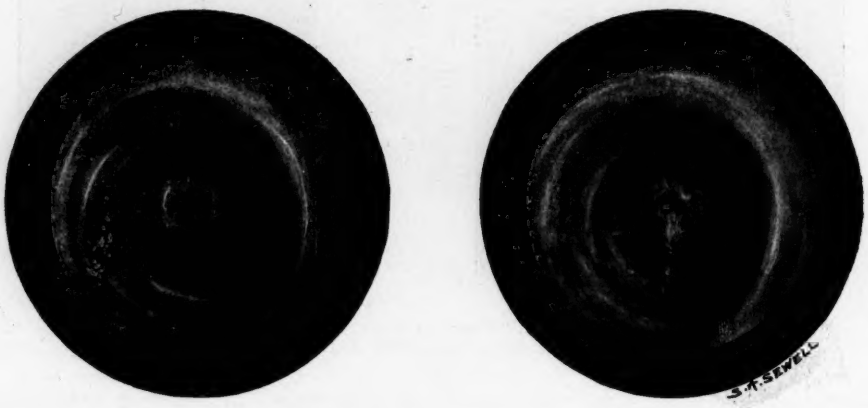


FIG. 102.—*Case* 12. J. P. The appearance of one of the ureteric orifices as seen by the sigmoidoscope: on the left at rest, on the right puckered and crenated during vermiculation and delivery of urine into the bowel.

developed pelvis, the pubes being separated to the extent of $2\frac{1}{16}$ in. (*Fig.* 101). The evacuation of the rectum still occurs rather frequently, and he wets the bed a little at nights. There is always a big stain, but the bed clothing is never soaked. He empties the bowel at 8.30 a.m., 10.30, 12 noon, 1.15, 4, 5.30, and just before going to bed about 8 p.m., and gets up three or four times each night. But there is a good deal of variation, and some days he does not go at 10.30 and 4, and only gets up once during the night. In this

respect he is invariably worse in cold weather. The evacuation is always liquid, and usually fæces and urine mixed; it is very slimy and has a horrible odour. The boy states that he can pass flatus without any accident, and the mother says that his trousers are never soiled.

On the morning that he came to the hospital to report he emptied the rectum at 9.15, and at 11.40 he was requested to do so in order to suppy a sample. There was no desire, and when he tried he found he was unable to oblige, but about ten minutes later he voided a couple of ounces of fæces and urine mixed. On another day soon afterwards he passed at about 10.30 some 3 oz. of liquid fæces, at about 11.30 about 1 oz. of fæces and urine, and at 12.30 some 7½ oz., mostly urine. The anus showed no excoriation whatever, and the sphincter grasped the finger firmly. With the sigmoidoscope one ureteric orifice was seen at a distance of about six inches from the anus. It was like a papilla or nipple, rounded, smooth, and of a pink colour. Every now and again a wave of peristalsis passed over it, and just before urine escaped from its extremity it became shrunken and crinkled, the edges of the terminal orifice appearing bright red like a cherry (*Fig.* 102).

Summary.—Case of ectopia vesicæ in a boy, with total incontinence. Operation at 10 years of age. Transplantation of both ureters into recto-sigmoid at an interval of three weeks. Good recovery and improving health ever since. In December, 1927, he was 13 years and 4 months old, and in better health than ever before. Weighed 3 st. 12½ lb. and was 4 ft. 4¾ in. in height. Has perfect rectal continence during waking hours, but is sometimes wet at night.

Case 13.—**Ectopia vesicæ. Transplantation of both ureters in two stages at two weeks interval. Two years later plastic on bladder. Septicæmia. Death.**

W. B., male, age 4 years. (Reg. Nos. 16984–5.)

This patient was a small, weedy boy with complete ectopia (*Fig.* 103). The parents were most anxious to have him put right, and pressed for an early operation. There was complete ectopia, with wide separation of the pubes.

First Operation, Sept. 28, 1925.—General anæsthesia. Mid-line incision. Much trouble from tendency of small bowel to escape from incision. Right ureter easily found and implanted into sigmoid. It was slightly dilated and thickened. Self-retaining catheter in rectum. Drain from near anastomosis removed in a week. Rectal tube came out at the same time. Boy made a very good recovery.

Fig. 103.—*Case* 13. W. B., at the age of 4, just previous to the ureter implantation.

Second Operation, Oct. 12, 1925.—Median incision reopened. Many adhesions of omentum and small intestine to parietes. The rectum was found very dilated—catheter passed into anus and much liquid fæces evacuated. The left ureter was two or three times the normal size, and very thick-walled, but it vermiculated naturally. It was divided and its lower end ligatured. A rubber catheter, size 8, was easily passed into the upper end, but it seemed too big, so a No. 6 was substituted, and fixed by an encircling ligature of catgut. No urine escaped either then or up to the time of completion of the anastomosis. This catheter was passed into the rectum and out of the anus and buried in the wall of the sigmoid with the ureter. This was not so satisfactory as in cases where the catheter was not used, and before completion the catheter was withdrawn until only its extremity remained in the ureter. At the end of the operation no urine was escaping from the catheter, and none could be sucked out with a syringe. The catheter was therefore removed, but a big tube was left in the rectum. The operation took an hour, and the boy was cyanosed throughout. He was chesty for a day or two, but this cleared up. The rectal catheter came out the day after operation, and afterwards the bed was continuously wet. He did not ask for the bed-pan. There was no renal attack, and the boy took food well. The abdominal drain was removed on the tenth day, and there was no leakage of urine from it. The patient went home three weeks after the operation. Just before leaving there were signs of rectal control developing, but the bed was still continuously wet. The mother was given instructions about the necessity of training the boy.

In February, 1926, the patient was quite well and continence was developing. In November he was still very well and was growing, but was extremely thin. The Education Authorities wanted him to go to school, and he began soon afterwards.

In August, 1927, the boy was very well in every way. He was attending school regularly and playing games just like other boys. He weighed 3 st. 2 lb., but looked very thin. The parents were advised to allow him to return to have the mucous membrane of the exposed bladder removed, and he was re-admitted for this purpose on Dec. 8, 1927. He still looked small and delicate and was very thin, weighing only 2 st. 12 lb. 3 oz. and being 3 ft. 11 in. in height. He was bright, cheerful, and intelligent, and took ordinary food very well. Both testicles were descended and normally developed. While lying in hospital rectal control was fairly good during the day for one to two and a half hours, but there was a good deal of incontinence at night. X rays showed separation of pubes to the extent of 2⅛ in. Examination on Dec. 13 of two separate samples of urine passed per rectum resulted as follows: First sample: Amount, 550 c.c.; reaction, strongly alkaline; albumin, present; blood, present (pyramidon); urea, 1·31 per cent. Second sample: Amount, 250 c.c.; reaction, strongly alkaline; albumin, present; blood, trace; urea, 1·62 per cent.

It was intended to carry out the operation on Dec. 13, and the boy was taken to the theatre for that purpose and anæsthetized. Dr. Markham, the anæsthetist, remarked that he was rather a feeble subject, but nevertheless the boy struggled vigorously while going under the anæsthetic, which was A.C.E. followed by open ether. Altogether the administration lasted for thirty-five minutes. The rectum was first examined. The anus grasped the finger, but not vigorously, and it at once became patulous after the introduction of the sigmoidoscope. On introducing the latter about 2 oz. of urine escaped from the lower rectum, and it seemed remarkable that this did not escape during the administration of the anæsthetic. When the instrument was advanced further into the bowel, beyond the rectal shelf, several further ounces of urine gushed out, making a total collected of 6½ oz., a good deal being lost. The latter came away almost clear, but with a lot of mucus, and following it a considerable amount of liquid fæces escaped. A careful and systematic search did not discover the ureters, and there was nothing to suggest where they might be hidden. Indigo-carmine, 1 c.c., was given by intramuscular injection, but there was no indication of blue discoloration in the bowel, and at the end of twenty minutes from its administration the search was discontinued. As this examination was rather prolonged it was not thought wise to proceed with the removal of the bladder, and the boy left the table at the end of thirty-five minutes in good condition. He very quickly recovered from this examination, and did not appear at all upset, certainly not more than is usual in ordinary children. Four days later the plastic operation on the bladder was carried out.

Third Operation, Dec. 17, 1927.—General anæsthesia was again employed, and he was under its influence for about forty minutes. The greater part of the vertical scar and the bladder were encircled by an incision and excised in one piece. The removal of the bladder opened up the cellular tissue of the pelvis, and left a deep hole leading to the recesses of the pelvic cellular tissue, as indicated in the drawing (*Fig.* 104). Several rather large vessels required ligature. The recti were widely separated, certainly to the extent of 1½ in. Their sheaths were opened and the muscles drawn together in the upper part, but this could not be completed towards the pubes as the tension was much too great. The deeper sutures were supported by flaps cut from the rectus sheath and turned over. by these steps the cavity left after removal of the bladder was diminished and partly covered, but it could not be completely obliterated. A tube was therefore brought from the depths, and the remainder was packed with iodoform gauze. The skin came quite well together except at the lowest part. This operation appeared to be well borne.

Progress.—On the day following operation there was nothing to cause anxiety, but on Dec. 19 the boy looked very ill. There was frequent vomiting, and he was tender in the left flank. The pulse was very quick and of poor tension. Saline infusions with digitalin and strychnine were used. The next day he appeared to be a little better. The kidney regions were fomented and the boy took a good deal to drink. By night he was worse; there was more vomiting, he looked very ill, and was restless. On Dec. 21 he was still very ill and the vomit was black. Until the previous night the bed had been soaked, but not since, suggesting suppression of urine. He was given water per rectum by the gravity method, and the nurse was astonished at the amount which entered the bowel and was retained. Unfortunately it was not measured, but it was much more than usual in a child, and certainly over two pints (a child of this age cannot be expected to retain more than about 10 oz.). There was no elevation of temperature, and the condition was looked upon as entirely due to renal insufficiency, and it was decided to expose the kidneys with a view to drainage, or decapsulation, or both, as indicated. About noon on Wednesday, that is, the fourth day after the operation, with local anæsthesia and a little gas and oxygen, this was carried out. Both kidneys were large and firm and there was no surrounding œdema. They were not unhealthy to the naked eye and the pelves were not dilated. In both the capsule was completely stripped, and this was done without any difficulty. The incisions were packed with gauze and left open, boric foments being applied. It struck the operator that by this method the kidneys could be directly fomented, or the patient

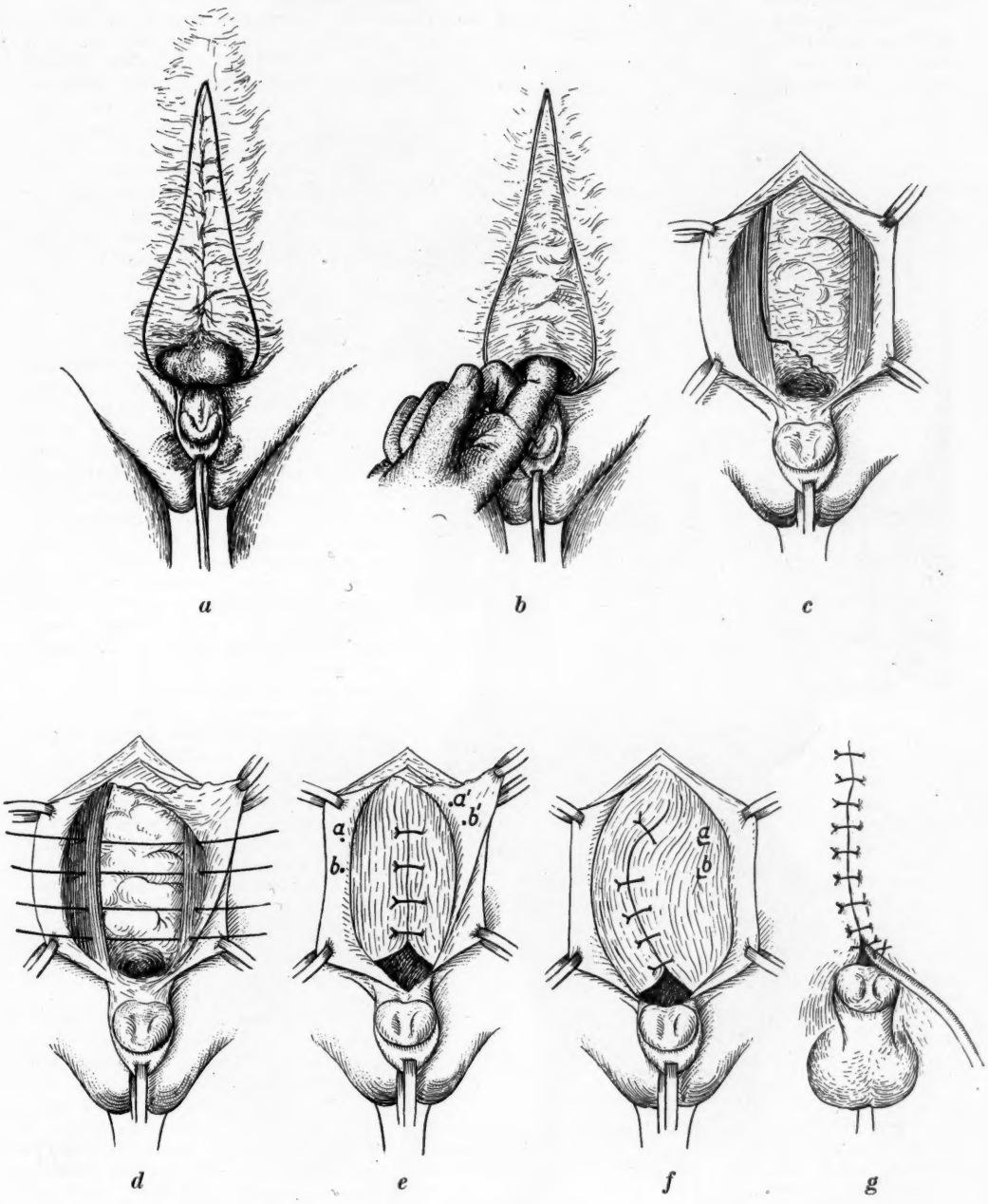


FIG. 104.—*Case* 13. A series of line drawings showing the steps of the plastic operation carried out. The lower part of the scar and the exposed bladder were first excised. In the next two diagrams the recti and much-stretched linea alba are shown. The recti are then shown drawn together, and finally the turned-up sheaths were overlapped and fixed by suture, the points *a*, *b*, to *a'*, *b'*. The drainage tube shown in the last diagram was brought from the depths of the pelvic cellular tissue.

could be put in a bath and the kidneys kept directly in contact with fluid of any temperature. This operation took about twenty minutes and the boy did not appear to be upset by the interference. Unfortunately there was no improvement and he died at 7 p.m.

POST-MORTEM EXAMINATION.—The body was emaciated, and there was some decomposition about the median incision. The colon could not be distended per rectum—i.e., fluid would not run in, and simply regurgitated through the flaccid sphincter. There was no peritonitis. The whole pelvis was filled with contorted, dilated, and adherent sigmoid, rectum, etc., so that nothing else could be seen. The kidneys, ureters, and whole colon and rectum, with the anus, were removed intact. On separating the left ureter some pus was noticed in the retroperitoneal tissue near its lower end. This seemed to have travelled upwards, either from the neighbourhood of the ureteric anastomosis on that side, or from the extraperitoneal cavity from which the bladder had been removed. The liver was slightly enlarged, soft, and very fatty, owing to recent acute change. There was some purulent pleurisy on both sides and a very little pleural fluid; no bronchopneumonia, only a little congestion the result of general septic invasion. The heart and pericardium were not affected.

FIG. 105.—*Case* 13. W. B. This patient died 2 years and 3 months after the implantation of the ureters. The drawing shows the parts removed after death as seen from behind.

The parts removed were subsequently carefully examined. The colon was filled with formalin from the ileum after suture of the anus. It was noticed that the fluid did not distend the ureters, and could not be made to do so even by manipulating the bowel, ureters, etc. The latter were filled by using a hypodermic syringe passed into the kidney pelvis on each side. When the fluid was subsequently removed from the colon it was carefully measured and found to be 1110 c.c.; some of the formalin had already escaped, and the bowel was not greatly distended, i.e., not tightly blown up. The condition of the parts as seen from behind is well shown in *Fig.* 105.

The rectum above the pelvic diaphragm was much thicker than below, and was pathologically hypertrophied.

The right kidney (*Fig.* 106) (the one which was anastomosed first) was slightly enlarged, measuring $3\frac{1}{2} \times 2$ in. It showed definite hydronephrosis involving all the calices. The cortex was generally diminished and the surface was scarred in several places, and opposite the scars the cortex was narrowest. The dilated pelvis was thickened, reddened, and contained muco-pus, and was very hyperæmic towards the calices.

The right ureter was dilated to about four times the normal size. In the prepared specimen the widest part was half an inch across. As it approached the right side of the bowel it was much narrowed in comparison, but actually about normal, or only a very little bigger. Exactly $1\frac{3}{4}$ in. of the ureter was buried in the bowel wall. The track of the

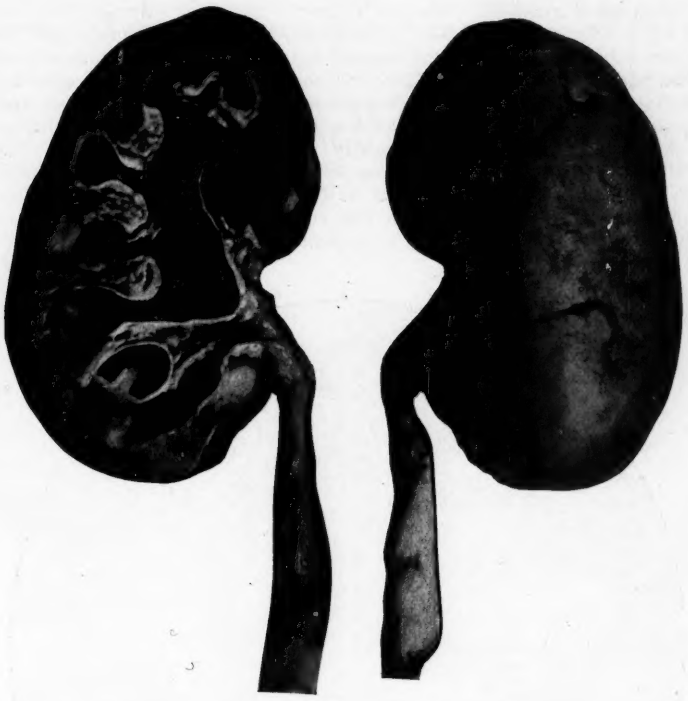


FIG. 106.—*Case* 13. W. B. Right kidney.

FIG. 107.—*Case* 13. W. B. Left kidney.

buried ureter could be seen from inside the bowel, which was raised up over it. The passage was oblique and gradual. The opening into the bowel appeared as a small depression, obscured by a mucous fold. In the specimen it was to the right and posterior. The part of the bowel into which the ureter opened was just above the pelvic diaphragm. The diameter of the opening was about $\frac{1}{10}$ in. or smaller. At first it appeared slit-like, but was dilated during the examination. This opening was quite hidden, and was only demonstrated after passing a probe down the ureter from above (*see Fig.* 120).

The left kidney (*Fig.* 107) was slightly smaller than the right. The pelvis was scarcely, or very little, dilated, and not in the least hyperæmic. The kidney substance looked healthy, but the cortex in the lower half was considerably diminished. The surface was scarred, but to a lesser extent than the right. (In both cases the capsule stripped very readily during life.) The microscopic appearances are shown in *Fig.* 108.

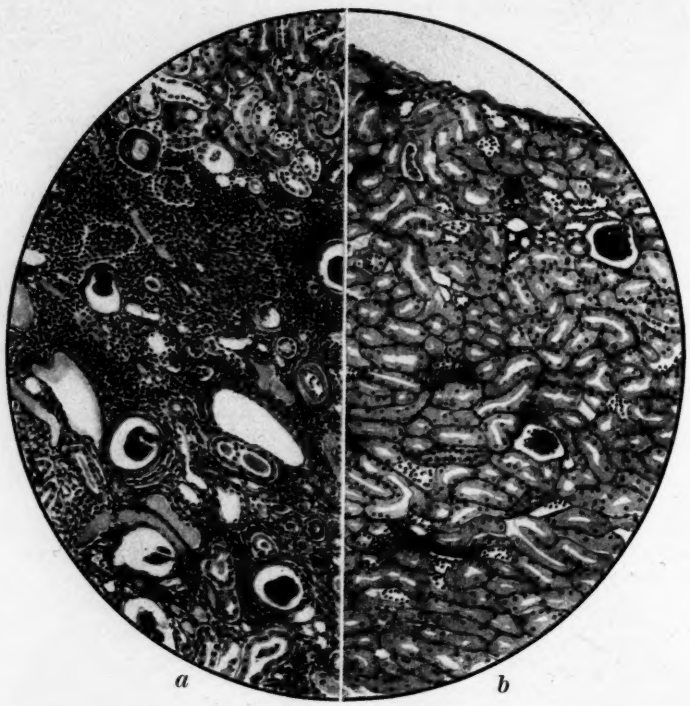


FIG. 108.—*Case* 13. W. B. Microscopic appearances of (*a*) right and (*b*) left kidneys. (× 60.)

The left ureter was about half the size of the right; it opened into the bowel to the left side of the bowel, and behind and at this point was considerably narrowed. The opening into the bowel, as seen from the lumen of the latter, was like a circular rosette raised at least $\frac{1}{4}$ in. from the surface of the mucous membrane. It was a little more than that in diameter, roughened on the surface, and like a wart or closely packed polypus (*see Fig.* 120). It opened into the bowel opposite the internal iliac artery, above the pelvic diaphragm. Two inches of this ureter were buried in the bowel wall.

By measurement it was found that the right ureter opened into the bowel $3\frac{1}{2}$ in. from the anus, whereas the left was 8 in. from that point—i.e., their orifices in the bowel were 5 in. apart, and were separated by a complete bend of the bowel, closely and firmly fixed by adhesions.

The rectum, below the pelvic diaphragm, was ballooned and thin-walled, with what looked like normal mucous membrane. The bowel (? upper rectum, lower sigmoid) above the pelvic diaphragm was very definitely dilated, thicker in its wall, and with reddened mucous membrane, in contrast with that in the bowel in the compartment above into which the left ureter opened. The remainder of the colon looked normal from the outside, though it was much larger than would be expected in a child of the same age. It measured 26 in. from the ileocæcal valve to the commencement of the sigmoid. The latter was so coiled and adherent that the length of it and the rectum could not be ascertained.

Case 14.—**Ectopia vesicæ and double inguinal hernia. Transplantation of one ureter by the method of Peters. Septic dermatitis and cancrum oris. Death.**

J. M., female, age 1 year 4 months. (Reg. No. 17407.)

HISTORY.—This child was the youngest of a family of five; she had been brought up on Glaxo. The parents were in very poor circumstances, and were more distressed about the encumbrance of the child than its welfare. It was quite obvious that they could not, or would not, be bothered with the child in its abnormal condition. Until the age of 7

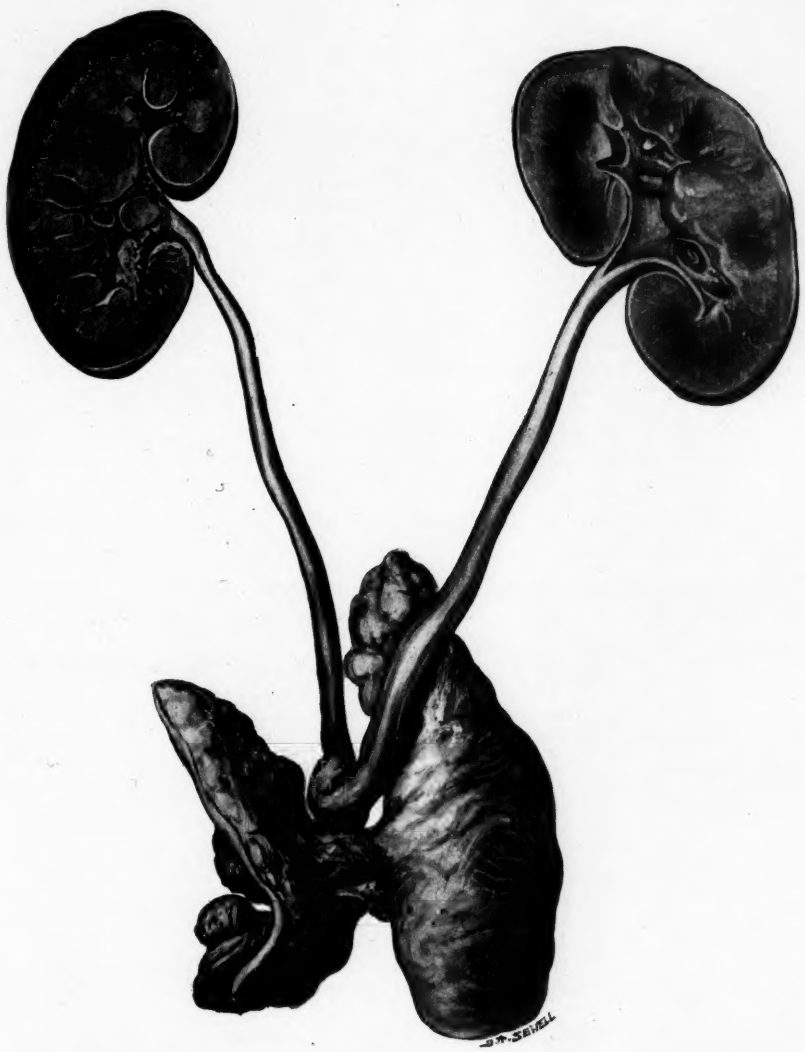


FIG. 109.—*Case* 14. J. M. Child of 1 year and 4 months. Left ureter implanted into rectum by Lendon-Peters method. Death at end of a week. The ureter had slipped out of the rectum and was lying in an abscess cavity. The corresponding kidney showed evidence of dilatation and ascending infection.

months this child did well, but it then began to suffer from prolapse of the rectum, probably the result of neglect. When seen the child was ill-nourished, peevish, and constantly crying. There was moderate prolapse of the rectum, but with a fairly good rectal sphincter. In this condition Dr. Dunlop Lickley kindly admitted the patient under his care at the Children's Hospital. The child was carefully fed and nursed, and was given seventeen doses of ultra-violet light, and had boric baths twice daily. Under this régime she steadily

improved, and in six months had gained 2 lb. 6 oz. She occasionally suffered from screaming fits, apparently associated with the descent of double inguinal herniæ. The rectal prolapse occurred only once, and that during the first week the child was in hospital. After five months' treatment the baby was transferred to the Newcastle Infirmary in very good condition.

Operation, May 28, 1926.—General anæsthesia. The left ureter was implanted into the rectum by the Peters method, no fixation sutures being employed. The patient stood the operation well. On May 30 the child was not well. It looked pale and ill. The temperature was 102·6°, and there was a small (?) anæsthetic burn on the chin. The latter spread rapidly, and a generalized rash appeared on the body. The condition was diagnosed as measles, and the child was sent to Isolation. The temperature remained high, 103° to 104°, and the child was very ill. The supposed burn on the face rapidly presented a condition like cancrum oris. The wound in the base of the bladder became very septic, and death took place just a week after the operation.

Post-mortem Examination.—General septic dermatitis, with large patch on the right cheek like cancrum oris. There was a small abscess behind the extroverted bladder, between it and the rectum on the same side as the ureter transplantation. The right ureter and kidney were normal, but the left ureter was dilated and thin-walled, and the corresponding kidney was about half as large again as the right, and was very soft and friable. The capsule stripped readily and on section the substance showed a condition of pyelonephritis. The pelvis and calices were dilated and contained some purulent urine, and there were several abscesses in the medulla.

Microscopically, this kidney showed a well-marked ascending simple infection along the tubules which had scarcely reached the cortex of the organ. The right kidney showed a well-marked parenchymatous degeneration, but no evidence of a true nephritis or of ascending infection.

The rectum and lower ends of the ureters were removed in one piece. When subsequently examined the left (transplanted) ureter was found to have slipped out of the rectum and was lying behind the bladder in the area in which the above-mentioned abscess was found (*Fig.* 109).

Case 15.—**This is described as a continuation of** *Case* 9.

T. L., male, age 8 years 8 months. (Reg. No. 17328.)

Case 16.—**Total epispadias with incontinence. Transplantation of ureters in two stages at three weeks' interval. Acute pyelonephritis. Recovery.**

J. H., male, age 3 years. (Reg. No. 18140.)

History.—The patient was a fine, healthy boy, weighing 2 st. 9½ oz., and 36½ in. in height. The urethra was open on its dorsal aspect throughout its whole length, and communicated with the bladder by an orifice which easily admitted a finger (*Fig.* 110). X rays demonstrated separation of the pubes to the extent of one inch (*Fig.* 111). When lying on the back a certain amount of urine collected in the bladder before it overflowed, but it all escaped involuntarily when the boy stood up. A No. 14 self-retaining catheter in the bladder enabled practically all the urine to be caught, and there was only a very little leakage round the tube. While in hospital awaiting operation he took his food well, and appeared to be in every way normal. An X-ray picture of the forearm and femur, made for subsequent comparison, showed well-formed, normal bones.

First Operation, Oct. 1, 1927.—General open ether anæsthesia. Trendelenburg posture. Median incision from just above the umbilicus to just above the bladder opening. This was a trifle over 4 in. long, and, with the aid of the self-retaining retractor, gave quite a good exposure. At first the parts looked alarmingly small, but this did not give rise to any real difficulty. The left ureter was selected for the first anastomosis; it was normal in size and easily identified. After incising the peritoneum over it, the ureter could be lifted from its bed and did not require any special separation. Its vessels were seen intact and were not interfered with. After dividing the ureter a spot was selected on the sigmoid convenient for the anastomosis—that is, where the necessary manipulations could be comfortably carried out. This point was a finger's length from the bottom of the pouch of Douglas, which proved by measurement to be 3 in. No clamp was used on the bowel, and the ureter was implanted by the method of Stiles, except that it was made to lie obliquely in the bowel, and not along the longitudinal band. One and a half inches of the ureter were buried. The bowel at the point where the ureter entered was fixed to the edge of the pelvic peritoneum. A small tube was brought from the region of the union and through the mid-line incision. The parietal wound was closed by figure-of-eight silkworm sutures. The operation occupied one hour and ten minutes. A catheter was left in the rectum at the conclusion of the operation, and from this, during three succeeding periods of twenty-four hours, 8 oz., 7 oz., and 12 oz. of urine were collected.

PROGRESS.—On Oct. 4 the boy appeared to be quite well, but without warning commenced to vomit and did so copiously for some hours. He soon got over this, but it may have been a kidney reaction. He certainly got thinner for a day or two and was quieter,

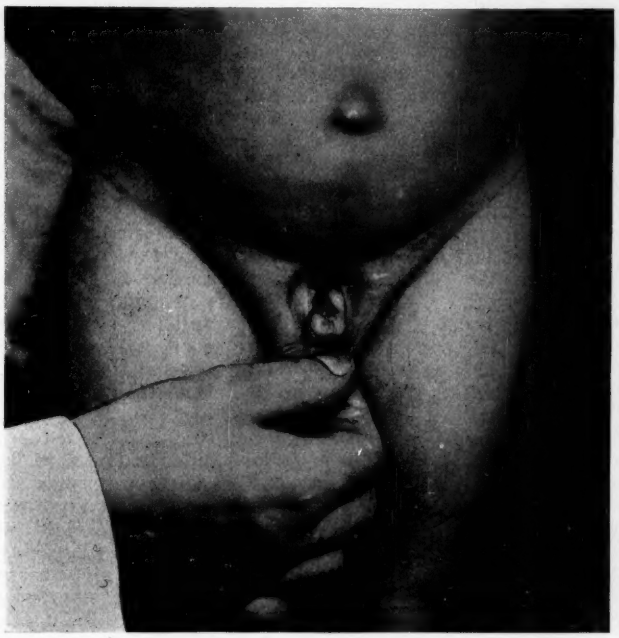


FIG. 110.—*Case* 16. J. H., boy, age 3. The testicles were descended. The pubes were separated to the extent of one inch.

FIG. 111.—*Case* 16. J. H. Skiagram of pelvis.

but he gradually picked up and by the 21st he appeared to be in about the same condition as before the operation.

SECOND OPERATION, Oct. 22.—The right ureter was implanted into the bowel; general anæsthesia and technique as before. The abdominal incision was 2 in. longer. The

sigmoid was adherent to the back of the parietes. The ureter was very small, and was purposely divided obliquely. A small tube was again brought from the region of the anastomosis. This time also the operation occupied one hour and ten minutes. At the end of the operation 1 oz. of liquid contents was evacuated from the rectum. A large catheter was stitched into the rectum as before.

PROGRESS.—The child stood the operation very well, but the condition was never quite satisfactory afterwards. He vomited almost continuously, a vomit which made his lips and face sore. Nothing stayed down; thirst was inordinate, and he drank cold water copiously and continuously. By the 24th his condition gave rise to great anxiety; the vomiting continued; he looked pinched and thin; the ears were a little cyanosed; and his pulse was very quick (130–140) and of low tension. The abdomen was neither distended nor rigid. After a restless night the condition on the morning of the 25th appeared desperate, and it was decided to explore the right kidney.

THIRD OPERATION, Oct. 25.—A minimum of general open ether anæsthesia. The right kidney was easily exposed by an oblique muscle-cutting incision. There was no extraperitoneal œdema, no obvious signs of gross mischief. The kidney was a little larger than normal, but the pelvis was not dilated. The latter was opened and its mucous membrane found to be intensely engorged, but there was no escape of urine. The capsule was stripped from the kidney and the wound packed with gauze and left almost entirely open.

PROGRESS.—The condition appeared to improve at once. In the afternoon, as he was restless and had not slept since the operation on the 22nd, a dose of $\frac{1}{16}$ gr. of morphia was given. At 10.30 p.m. he was found restful, of better colour, and with a pulse of good volume. He had not vomited since 3.30. The next day, the 26th, the boy looked much better. There was a little vomiting and the abdomen was a little distended. The catheter was removed from the rectum. Large foments were applied to the right flank and abdomen. Calomel and pituitrin were given, and in the evening there was some slight action of the bowels. During the day he slept a good deal and was altogether more restful. Afterwards he steadily improved and only vomited once or twice. On the eighth day following the exposure of the kidney, there was some escape of urine from the incision for the first time.

By the end of November he was greatly improved. The mid-line incision had gaped a little and healed by granulation. Now both incisions were soundly healed. The boy was taking food again and looking well. He weighed 1 st. 11 lb. 2 oz. So far as could be ascertained there was no sign of rectal control; when he left hospital a few days later, he was wrapt in a napkin like a baby, and this was frequently wet and had to be changed. By the end of the year the mother reported that the child had been very ill since going home but was now much better; was able to be up; was walking; and had permission from the doctor to go outside. "Has nearly got control of his bowels."

REPORT ON URINE.—The urine in this case, both before and after operation, was carefully examined under the supervision of Dr. J. C. Spence, whose report follows:—

Sept. 27–28 (*before Operation*), *Urine Collected at Intervals from a Catheter in the Bladder for Twenty-four Hours*—

	Amount	Specific Gravity	Urea
2.30 p.m. to 4.30 p.m. ..	78 c.c.	1019	1·19 per cent
4.30 p.m. „ 8.0 p.m. ..	46 c.c.	1015	1·81 „ „
8.0 p.m. „ 2.0 a.m. ..	105 c.c.	1022	2·31 „ „
2.0 a.m. „ 5.30 a.m. ..	105 c.c.	1014	1·62 „ „
5.30 a.m. „ 8.0 a.m. ..	170 c.c.	1006	1·35 „ „
8.0 a.m. „ 2.30 p.m. ..	180 c.c.	1015	1·31 „ „

Trace of albumin; numerous red blood cells; some pus cells.

Sept. 28, *Urea Concentration Test* (10 grm. urea).—

	Amount	Specific Gravity	Urea
1st hour	140 c.c.	1112	1·87 per cent
2nd hour	65 c.c.	1013	3·12 „ „
3rd hour	70 c.c.	1016	3·81 „ „

The chief points in these results are: (1) High concentration of urine urea (3·81) after urea; and (2) No fixation of specific gravity (varying from 1006 to 1022 in twenty-four hours). These are to be regarded as evidence of good renal function.

Blood-urea.—It was found impossible to get blood for estimation on the 27th or 28th. Blood was obtained only at the first operation on Oct. 1, when the patient was under an anæsthetic; this was 78 mgrm. per 100 c.c.—higher than normal, but probably accounted for in part by the anæsthesia.

Nov. 25, *after both Ureters were Transplanted.*—Urine collected from the rectum contained 1·94 per cent urea. Blood-urea, 39 mgrm. per 100 c.c.

Nov. 29.—Blood-urea, 40 mgrm. per 100 c.c. The blood-urea estimations of Nov. 25 and 29 are slightly raised, and to be taken as evidence of slight impairment of renal function.

Report.—The progress of the renal function of this case should be followed by repeated blood-urea estimations. A steady rise from the present level of 39–40 mgrm. per 100 c.c. would denote progressive deterioration.

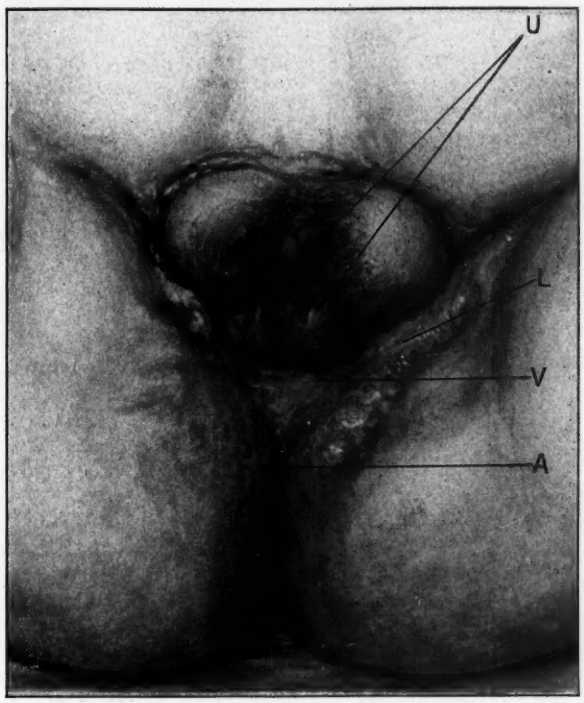


FIG. 112.—*Case* 17. G. M., a little girl 3 years and 8 months old. The parts before operation. The pubes were widely separated, but the connecting ligament was so strong that the child could be lifted from the table by a finger in the rectum. Note the excoriation of the labia and buttocks.

Case 17.—**Ectopia vesicæ. Transplantation of one ureter.**

G. M., female, age 3 years 8 months. (Reg. No. 18139.)

HISTORY.—This patient was the third child of strong, healthy, sensible parents, the other children being normal in every way. The child was fair-haired, anæmic, and delicate-looking. In addition to the ectopia the whole bladder area was herniated and the linea alba was very wide (*Figs.* 112, 113). Weight 1 st. 9 lb. 10 oz., height 33 in. The shape of the head and slight thickening about the epiphyses suggested rickets. The patient was under observation for a week and during this time took food well and appeared normal in every way. Urine was collected by ureter catheter from both kidneys. Analysis by Dr. Spence gave the following results (Dec. 13, 1927): Specimen from left ureter: Reaction, acid; albumin, present; urea, 1·5 per cent. Specimen from right ureter: Reaction, acid; albumin, present; urea, 0·5 per cent. Mr. John Brumwell also catheterized the ureters and made pyelograms of both kidneys. This examination showed both ureters were dilated, the right more than the left (*Fig.* 114).

FIG. 113.—*Case* 17. G. M. To show the hernia of the bladder in profile.

OPERATION, Dec. 17, 1927.—Combined spinal (stovaine ½ gr., strychnine $\frac{1}{120}$ gr.) and general ether anæsthesia. The Trendelenburg posture was adopted ten minutes after administration of the spinal anæsthesia. In a few minutes respiration became very slow and sighing, and caused some anxiety. At first the abdomen was quite flaccid, and there was no tendency for the bowel to escape, but as the effects of the spinal anæsthesia wore off, prolapse of the intestine occurred, and was troublesome. This difficulty was exaggerated because the embarrassed

respiration following the spinal anæsthesia deterred the anæsthetist from using more ether. The right ureter was dilated to about four times the normal size, but the left was only half as big. The right vermiculated very vigorously on stroking. It was implanted into the sigmoid by the method of Coffey. The union seemed secure, but the method was not considered as satisfactory as the Stiles plan. The operation was more difficult than usual because of the general smallness of the parts, the fact that the ureter was almost at right angles to the bowel, and because of some anxiety about the anæsthetic. The whole proceeding occupied one hour and fifteen minutes, and the child was returned to bed in very good condition.

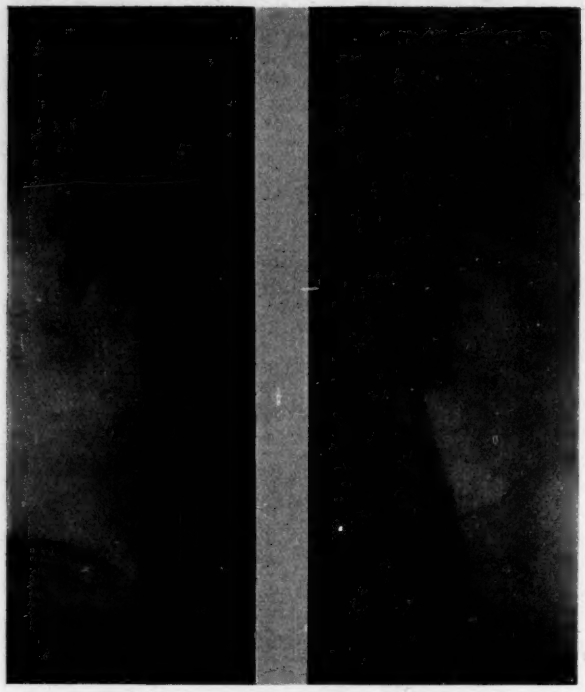


FIG. 114.—*Case* 17. G. M. Pyelogram made by Mr. John Brumwell. The dilatation of the right ureter (on the right side of the figure) was confirmed at operation.

PROGRESS.—Recovery was quite uneventful and without any definite evideace of kidney reaction. The incision healed rather slowly and gaped a little, but the granulations were quite healthy. The child went home at the end of three weeks, and was subsequently reported to be doing well.

This child was re-admitted in May, 1928, when the second ureter was transplanted by the Stiles method. Recovery was again quite uneventful, and the patient continues to make good progress (January, 1929).

I am very much obliged to many doctor friends who have taken so much trouble to keep me informed of the after-progress of these cases.

THE BEST AGE FOR THE OPERATION.

This depends a good deal on the size, development, and general health of the child. The earliest age at which I have personally operated by the intraperitoneal method is 3 years. At that age the parts are small and the pelvis is difficult of access, and unless for some very special reason I do not propose to operate again so early. In my view the age of election is between 5 and 7, depending on the considerations already mentioned.

EXACT TECHNIQUE OF METHOD EMPLOYED.

In some of the patients potassium citrate has been administered for a week before operating, but otherwise no special preparation has been used.

I propose to describe the operation as I have carried it out, leaving suggested modifications, etc., to be dealt with in the section devoted to ALTERNATIVE METHODS (p. 173).

There are some few anatomical peculiarities which need to be emphasized. In cases of complete ectopia the surgeon must realize that the umbilicus is merged in the apex of the ectopic bladder, and that there is always separation

of the pubes, which may be of very considerable degree—in this series from 1 in. to as much as 3½ in. The linea alba is correspondingly wider than normal, and is represented by a strong, fibrous structure which, at its lowest part, merges with a fibrous ring surrounding the upper circumference of the ectopic bladder. In a good many of these cases the ureters are dilated, and in one of my youngest patients (*Case* 17) this was demonstrated by the method of pyelography (*see Fig.* 114), which was carried out for me by Mr. John Brumwell. Possibly the dilatation may develop subsequently in some of the cases, but it is often present as an associated part of the deformity.

The ureter is well supplied with blood-vessels, and many of them run for a considerable distance in the loose cellular tissue which forms a sort of sheath in which it lies. It is essential that as far as possible these vessels should be spared, and when the ureter is lifted from its bed, if they are not deliberately divided, they may often be preserved if the surgeon uses the method of blunt dissection or gauze stripping. In *Fig.* 89 such a vessel is seen lifted from its bed with the ureter, but remaining unharmed at the completion of the operation.

The difficulty of ensuring an aseptic field in the presence of the exposed mucous membrane is evidently more theoretical than practical, for, with the doubtful exception of *Case* 11, there has been no serious infection attributable to this source.

In most of my cases general anæsthesia, induced by A.C.E. and followed by open ether, has been employed. In younger subjects the tendency of the intestines to escape has caused embarrassment, and to avoid this it has been suggested that the patient should be put in the Trendelenburg posture before the administration of the anæsthetic. I have tried combined spinal and general anæsthesia, and it has been helpful from this point of view, but it is an anxiety in the young child, and especially where the Trendelenburg posture is employed. After all, temporary evisceration ensures the best view of the pelvis, and is not serious provided that due care is exercised in covering the exposed bowel and keeping it warm and moist.

In cases of ectopia the exposed bladder is first packed with iodoform gauze. I have always employed a vertical incision from the umbilicus where it exists, and otherwise from its position down to, but not through, the ring of dense fibrous tissue which surrounds the upper border of the exposed bladder. Once the peritoneum is opened, the intestines are packed away in the upper abdomen so as thoroughly to expose the pelvis with the sigmoid and upper rectum.

The right ureter is now always selected for the first anastomosis, because it can be most conveniently implanted into the lowest part of the selected bowel. In all cases I have easily identified the ureters, which have invariably been found lying in their normal position crossing the iliac artery. The only doubt will arise when the ureter is much dilated, but such doubt will always be set at rest by the vermicular movements of the ureter, which occur naturally at regular intervals, and which can be set up by stroking over its course with a closed artery clip, or by gently pinching the tissues in the neighbourhood with forceps.

The sigmoid is drawn up and to the left, and the site for the anastomosis is marked by a catch forceps introduced into the anterior longitudinal band. The first ureter is joined to the bowel at the lowest point which can be conveniently reached for suturing, and this in children will probably be a finger's length, say 2½ to 3 in., from the bottom of the rectovesical pouch. In the more roomy pelvis of adults this point may be still nearer to the bottom of the pouch.

The ureter is now exposed by picking up the peritoneum which lies over it, and by incising this structure for a distance of two or three inches, depending again on whether the subject is a small child or an adult. The ureter is laid hold of with fine, mouse-tooth forceps and gently lifted from its bed of cellular tissue near the bladder; it is caught with an artery forceps as low down as possible, and divided across above the forceps. I have not found any forceps which will conveniently catch and hold the ureter sufficiently firmly to prevent slipping and at the same time without crushing, so that I now leave the lumen of the upper end unguarded, and merely take a small hold of one side of its wall with a catch forceps. The upper end of the ureter, which is to be used for the implantation, is then separated from the cellular bed in which it lies. This is easily accomplished by the aid of a dissecting forceps, or a small piece of gauze held in a clip used as in the method of gauze stripping. Only a little more of the ureter is separated than is going to be buried in the bowel wall, so that probably 2 in., or at most 2½ in., will suffice, of course depending on the size of the subject. The large amount of ureter shown separated from its surrounding cellular tissue and elevated from its bed, in articles which have recently appeared in the medical press, is very misleading. The greatest care is taken not to divide or tear the small blood-vessels which are found passing into the ureter, for they will usually strip up and stretch sufficiently. The upper end of the ureter is thus first separated so that by turning it upwards its lumen is kinked and an escape of urine is avoided even in the absence of an occluding clip, but as an extra precaution its open end is laid in a mop of gauze. The exposed mouth of the lower end of the ureter is then carbolized, ligatured with catgut (No. 3/0 chromic), and allowed to retract into the cellular tissue towards the bladder.

A small ⅜-in. incision is now made through the longitudinal band on the large bowel in the transverse direction and just above the point already marked by the catch forceps. This incision cuts through the muscular coat and exposes the mucous membrane, which is pulled up into the incision and incised just sufficiently to allow the ureter to be introduced into the lumen of the bowel without being constricted.

The upper end of the divided ureter is then trimmed obliquely, and a catgut suture (3/0 chromic gut) is passed through its pen-nib end and tied. One end of this suture is cut so as to be left 3 in. long, and this portion is coaxed with a probe into the open mouth of the ureter, so that it occupies the lumen of that portion of the tube which has been lifted from its bed. This is the catgut urine guide of Charles Mayo. These steps are illustrated in *Figs.* 115 and 116. The long end of the suture is then threaded on a curved needle, which is passed into the lumen of the bowel and brought out half an inch lower down. By means of this thread the ureter is drawn

into the lumen of the sigmoid; by tightening the stitch it is made to lie close up against the mucous membrane of the bowel, and is there fixed by tying the suture on the peritoneal aspect of the bowel. Usually the hole into the lumen of the sigmoid is a little too large to accommodate the ureter, and is diminished by one or two interrupted sutures so that it lies snugly round the latter.

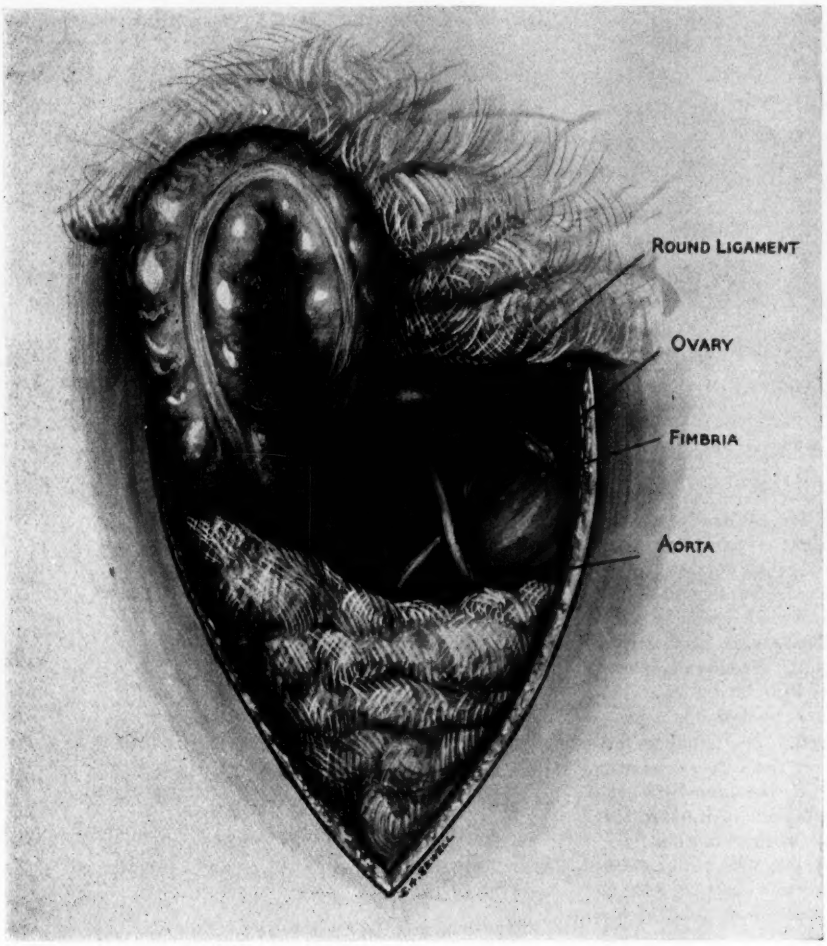


FIG. 115.—*Case* 17. G. M. The pelvic contents with ureters as exposed in the first stage of the operation. Note the dilatation of the right ureter, which was previously demonstrated by pyelography. For the sake of clearness the posterior parietal peritoneum is not shown.

The process of burying the ureter is now carried out by a series of four interrupted sutures (3/0 chromic gut) which take a good hold of the bowel on either side, but at such a distance that when drawn over the ureter the latter has ample room to lie in the groove so made without fear of causing its constriction. The amount of bowel wall required for this purpose will, of course, depend on the size of the ureter in each individual case. The first of these inverting sutures commences just above the fixation stitch, and

they are inserted $\frac{3}{8}$ in. apart. The second and third stitches just catch the outer wall of the ureter. The ureter is buried obliquely in the bowel wall so that when the anastomosis is completed it passes comfortably direct from the opening in the posterior peritoneum to the intestine without kinking. A second and final row of six sutures buries the fixation stitch and the first row of inverting sutures. Two additional sutures are passed through the outer wall of the bowel near the point where the ureter

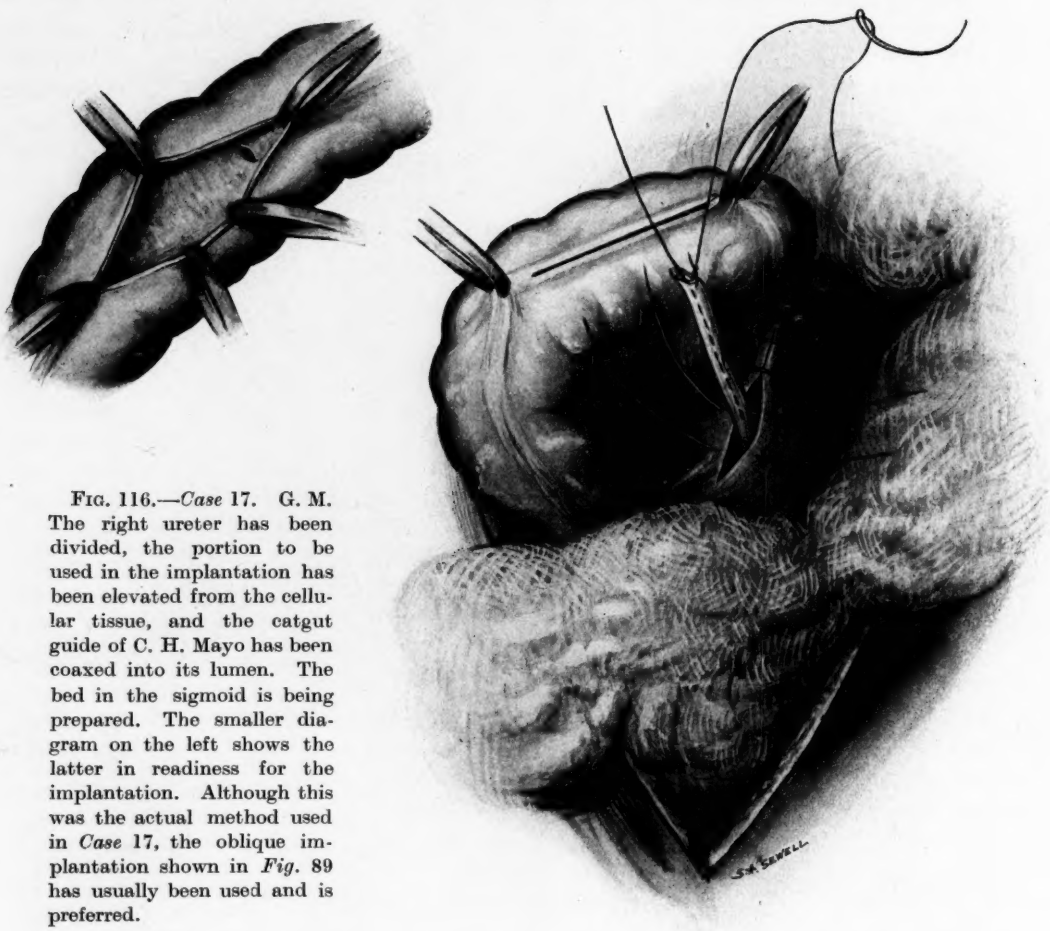


FIG. 116.—*Case* 17. G. M. The right ureter has been divided, the portion to be used in the implantation has been elevated from the cellular tissue, and the catgut guide of C. H. Mayo has been coaxed into its lumen. The bed in the sigmoid is being prepared. The smaller diagram on the left shows the latter in readiness for the implantation. Although this was the actual method used in *Case* 17, the oblique implantation shown in *Fig.* 89 has usually been used and is preferred.

enters, and are used to fix the bowel at this point to the edges of the peritoneal slit, as shown in *Fig.* 89.

When the anastomosis is completed the ureter should not be visible, for it should pass directly from its bed behind the peritoneum into the channel in the bowel. A fine rubber tube, about $\frac{1}{8}$ in. in diameter, is brought from the neighbourhood of the anastomosis either out through the lowest part of the median incision, or up behind the peritoneum to an independent opening in one or other iliac fossa, the most direct route being followed. After removing the gauze from the pelvis especial care is taken to protect the small

bowel by covering it with the omentum, and the parietal incision is closed. Whenever possible the peritoneum is sutured by a continuous stitch, but the main support for the wound is a series of figure-of-eight silkworm sutures one inch apart, and tied over rubber tubes. A few intermediate catgut stitches in the aponeurosis are valuable. Great care must be taken to close the extreme lower end of the incision, for this tends to gape, and in one case (*Case* 3) a piece of small intestine escaped and became strangulated, necessitating operative interference for its return.

At the conclusion of the operation a large rubber catheter (size 14) of the self-retaining type is left in the rectum in the hope of preventing an accumulation of urine, or urine and fæces. If it does not slip out spontaneously it is removed on the fourth day. In the cases where the bladder is exposed, the dressing of the incision must be kept separate from the dressing over the bladder; but in actual practice there has been no untoward incident due to the soiling of the incision from this cause. In examples of complete epispadias it is usually possible to introduce a self-retaining catheter into the bladder, and to draw off the urine in this way until the second ureter can be dealt with.

The operation in my hands has occupied from forty minutes to an hour, depending for the most part on the size of the pelvis. There has been very little shock, even in the youngest children. Urine commences to escape from the rectum within an hour or two, and at first, and for some few days, flows almost continuously. The bowels act without help, but sometimes a dose of calomel or castor oil has been administered if indicated.

The mild attacks of kidney infection which may come on during the immediate convalescence are usually ushered in with some pain in the affected side. On the other hand, sudden collapse or a rigor may mark the onset. The temperature soon runs up to 102° or 103°, and the pulse is correspondingly quick. The next day there is tenderness in the loin, and soon after the enlarged and tender organ may be felt. In three or four days the symptoms have usually subsided. It is surprising how little the patients seem to be upset by these attacks.

After-treatment.—No special form of after-treatment has been adopted, the patients being treated as after any ordinary laparotomy. It might help to ward off attacks of mild renal infection, and might hasten the process of stabilization, to give plain water by the bowel, and in future I am disposed to give this plan a trial.

Implantation of the Second Ureter.—This is deferred until the patient has completely recovered from the first interference. As a rule, a fortnight or three weeks suffices for this purpose. At the second operation I have always re-opened the original incision. The omentum is usually adherent to the abdominal wall, but there are only a few flimsy adhesions in the pelvis, and I have never found these obscuring the parts to

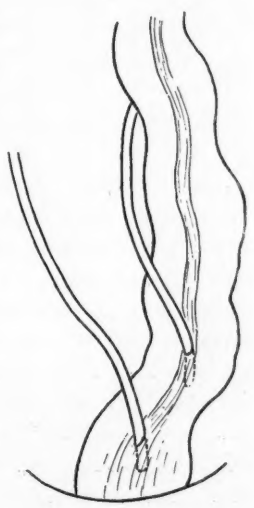


FIG. 117. — Showing the proper disposition of the transplanted ureters in relation to the bowel.

an inconvenient degree. The site of the first anastomosis is usually quite hidden, and I think it is unwise to attempt to expose it.

The second ureter is usually the left, and it is exposed as it passes over the pelvic brim, and is joined to the bowel on the inner side of the recto-sigmoid, the disposition of the two ureters being as indicated in *Fig.* 117. The details of this second stage are precisely the same as for the first operation.

REPAIR OF THE LOCAL DEFORMITY.

The repair of the local deformity is not such an easy problem as it appears. The excision of the mucous membrane of the bladder may be attended with very considerable hæmorrhage, and, even with the greatest care, in one of my cases (*Case* 3—a young adult of 19) the blood loss was enough to affect the patient very considerably. It is probably easier to excise the whole thickness of the bladder wall, but after this has been accomplished a large hole is left between the recti muscles leading into the pelvic cellular tissue, and from the depths there may be an amount of oozing which can only be controlled by the introduction of gauze packing. It sounds reasonable to talk of drawing the recti together, and covering the sutured muscles with the undercut skin from either side, but as a matter of fact the wide separation of the pubes, which is universal in cases of ectopia, renders this very difficult (*see Fig.* 104). In the one female case in which I have repaired the vulval region after excision of the bladder mucous membrane, I had very considerable difficulty in securing approximation because of the tension of the soft parts. Even after reasonable apposition had been obtained, the amount of tension was sufficient to cause some of the stitches to cut out. It is not even easy to be sure that the whole of the mucous membrane of the bladder has been removed, and in cases where this has apparently been carried out successfully, an island has sometimes remained which continues to be red and moist.

C. J. Bond[6] considers that the mucous membrane of the exposed bladder changes its character and comes to resemble the ordinary skin of the abdominal wall, and that therefore it is unnecessary to interfere for its surgical removal. On the other hand, Charles Mayo[7] and others have drawn attention to cases in which epithelioma has developed on the exposed mucous membrane, and they have used this as an argument in favour of its removal. In my experience I have seen neither of these developments, but I think that, on general grounds, it adds to the comfort of the patient if the external, and obvious, deformity is repaired as far as possible. In some cases in which the ectopia falls short of completeness, it may be possible, even in the male, so far to close the anterior aspect of the bladder and the urethra as to make the patient appear more or less normal. In these lesser degrees of deformity the problem is not so difficult, as there is not such wide separation of the pubes. In complete epispadias the gap between the bladder and the dorsal surface of the urethra can be readily covered in and the parts restored wonderfully satisfactorily. In *Case* 8 (*Fig.* 96), by such intervention the copulative and procreative faculties appear as if they would be abundantly restored.

Among the many alternative methods suggested for dealing with ectopia, I still remain attracted by the plan suggested by Trendelenburg of dividing the sacro-iliac joints with the idea of securing approximation of the pubic bones so that the bladder may be pushed back into position and be secured by suture of its anterior margins. This manœuvre might be helpful after successful transplantation of the ureters, as one of the steps towards the more complete repair of the deformity associated with the ectopia itself.

OPERATIVE MORTALITY AND COMPLICATIONS.

In this series of 17 cases it will be seen that there have been 4 deaths directly due to the operation, a mortality of 23·5 per cent. Since most of the cases have been dealt with in two stages there have been 28 separate operations, making the mortality 14·3 per cent. It we take the number of times the separate ureters have been transplanted, we have 29, with 4 deaths, equal to a mortality of 13·8 per cent. The Mayos, in a series of 60 cases, had a mortality of 13·33 per cent.

In my own series the cause of death in three of the cases was peritonitis. In the first patient (*Case* 4) this resulted from sloughing of the ureter, with pelvic peritonitis. There was also an acute ascending pyelonephritis. In that case both ureters were transplanted at one sitting. In the next death (*Case* 6) the peritonitis was due to a direct leak from the second ureter. The latter was much dilated and the last fixation stitch had entered its lumen. The third death (*Case* 11) was also the result of peritonitis, following the first ureter transplant. In this case the anastomosis was intact, and the pathologist was inclined to think that the infection had arisen in the neighbourhood of the abdominal incision.

The fourth death occurred in *Case* 14, a baby of 1 year and 4 months. One ureter only was transplanted, by the Lendon-Peters method, and the child died of a general septic dermatitis with cancrum oris. Post mortem an abscess was disclosed behind the bladder, and the end of the ureter was found to have escaped from the rectum. This retraction of the ureter had evidently occurred some time after the anastomosis, because the ureter was found dilated and the kidney enlarged and infected.

Most operators have noticed that the fatalities have occurred either when both ureters have been transplanted at one sitting, or after the transplantation of the second ureter in the divided operation. In a case operated upon by a colleague, which he very kindly allows me to mention, the child of 4 died on the tenth day following the anastomosis of the second ureter. During the days which elapsed after the operation the child vomited continuously and rapidly wasted. At the post-mortem a septic peritonitis was found, most marked in the pelvis, where there was much purulent fluid and lymph. The ureter last transplanted was markedly dilated as far as the pelvic brim, at which point it had sloughed and given way. The part of the ureter between the pelvic brim and the bladder was much thickened, and intensely black on its mucous surface (*Fig.* 118). The corresponding kidney was enlarged, and showed gross evidences of infection spreading into the substance from its distended and infected pelvis. Recovery after transplantation of the first ureter to be dealt

with in this case had been without incident. At the post-mortem the anastomosis looked sound and the kidney was apparently unaffected. A more critical examination showed that this ureter was completely obstructed in its passage through the bowel, and it is questionable whether the anastomosis had ever functioned. Quite probably the absence of the customary reaction on that side had failed to protect the opposite kidney from the severe inflam-

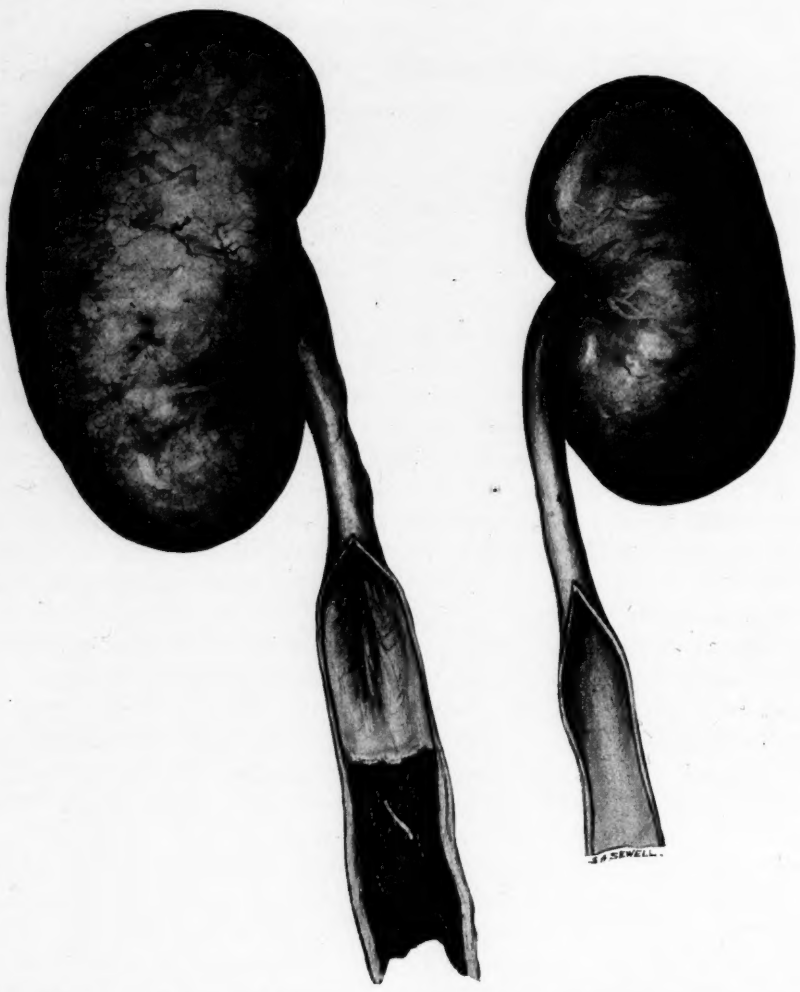


FIG. 118.—Gangrene of the ureter as found post mortem 7 days after transplantation into the bowel. The corresponding kidney is enlarged and was infected.

matory troubles which followed the second operation. It is in guarding against a sequence of this sort that the catgut urine guide of Charles Mayo is so valuable.

The reiteration of the causes of death in my cases goes to show the wisdom of the prophylactic operative measures which have now been incorporated in the routine operation—namely, the two-stage operation, the catgut urine guide, and the drain tube from the site of anastomosis.

GENERAL HEALTH OF THE RECOVERED CASES.

A perusal of the case records will show that the general health of the ten surviving patients is not far removed from normal, as judged by ordinary standards rather than clinical laboratory tests.

It takes time for the system to become accustomed to the altered state, and it is a question of months or even as long as two years before the condition of the patient can be said to have become stabilized. In the intervening period they are acquiring complete rectal toleration and the kidneys are presumably accommodating themselves to the element of constant mild infection. It may also be that there is continuous absorption of urine from the bowel,

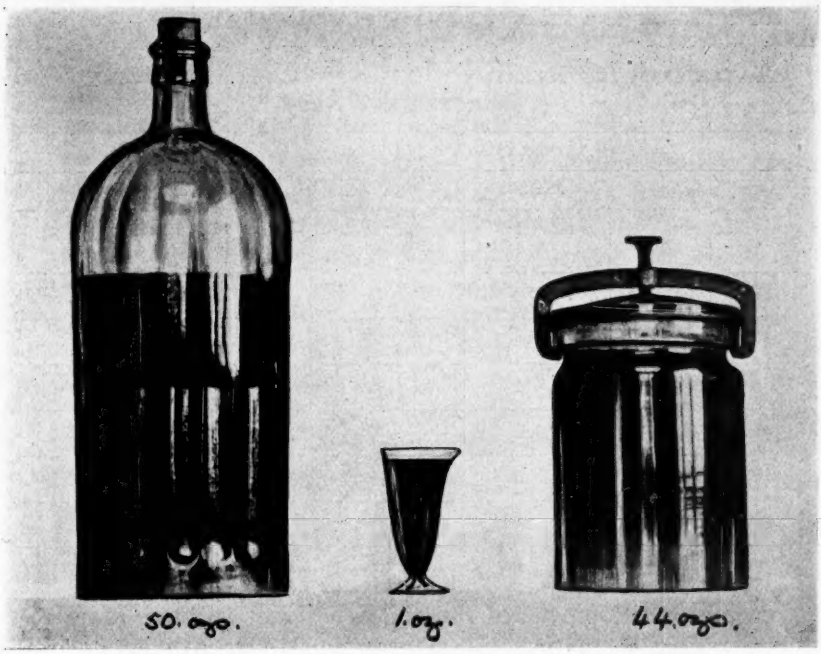


FIG. 119.—*Case* 9. T. H., a boy age 4 years, after implantation of the ureters into the bowel. To represent graphically the horrible discomfort and distress that must attend total incontinence of urine. The Winchester quart contains the normal daily secretion, and the 44 oz. in the specimen jar is the amount passed per rectum in this case after successful transplantation of both ureters.

and this may have some effect on the general nutrition and well-being. Whatever the cause, the records of the cases show that the condition in the first two years is not so satisfactory as afterwards. This is important from a practical point of view, and I think that during this period it is wiser not to attempt any such operative interference as may be desirable for the removal of the bladder mucous membrane or other plastic procedures. Fortunately during this period of stabilization the patients are not ill in the sense of being laid up, and in fact the new-found blessing of continence (*Fig.* 119) buoys them up so much that they can afford not to be depressed about any little physical weakness that may be present. They sleep and eat well and are ordinarily

active, but they keep thin, or even get thinner, and may be anæmic and seedy. When stabilization is complete they fill out, gain colour, and increase in strength and happiness. The change is often very striking, and has usually been a matter for remark by their friends. Eventually they get so well that they are able to do just as others of their age. Thus children attend school and enjoy games with their playmates, while older patients are able to work and to assume the responsibilities and duties befitting their station.

Judged by the standard of weight and its relationship to height and age, many of the patients are below normal; but the fact must not be overlooked that in almost every case, before the operation they were smaller and less developed than children of their own age. This particularly applies to *Cases* 1, 7, 12, 13, and 17, who could only be looked upon as delicate children, and unsuited for any but the most necessary operation.

TABLE SHOWING RELATION OF AGE, WEIGHT, AND HEIGHT (CORRECTED FOR SEX).

URETER TRANSPLANTS				NORMAL	
Case	Age	Height	Weight	Height	Weight
		ft. in.	st. lb.	ft. in.	st lb.
2	36	5 1½	7 2	5 1	8 9
3	29	5 10	10 7	5 7¾	10 12
1	24	5 4½	7 9	5 7¾	10 8
8*	19	5 4½	8 9	5 7¼	9 13½
5	16	5 0	8 9	5 1¾	8 1
7	14	4 2¾	4 2¾	4 11¼	6 8
12	13	4 4¾	3 12½	4 9	5 12½

* Only one ureter transplanted.

The original development of the children seems to have more to do with the ultimate result, so far as general health and strength is concerned, than anything associated with the actual operation. For instance, *Case* 3, who was not operated upon until he had attained the age of 19 years, was a big, strong lad at that time. Convalescence was interrupted by intestinal obstruction, and he was submitted to a plastic operation during the early weeks following the transplants, yet he has developed still further and is able to carry out the ordinary duties of a farm worker. *Case* 5 was very ill after the second transplant, either as the result of some sloughing of the ureter or perinephritis, but in spite of this she has grown big and strong, and is more robust than any of the other patients. *Case* 10 did very well and enjoyed really excellent health until overtaken by an attack of intestinal obstruction, and yet at the post-mortem one of the kidneys showed gross dilatation and evidence of infection. The case of T. L., *Case* 9 and 15, is also illustrative, for he has apparently only one functionally active kidney, and that with a greatly distended ureter and liable to attacks of infection, and yet his general health and development appear to be little affected. *Case* 2, who married

since the operation, has become the proud mother of two healthy children, and is now, thirteen years later, wonderfully well and leading a life of great activity.

RECTAL TOLERATION.

Rectal toleration does not develop at once, but the time required for the lower bowel to become accustomed, not only to the presence of urine, but to the unwonted amount of fluid contents, is very variable. As might be expected, the younger the subject, the less the control at first, yet all but the youngest patients have learnt to ask for the bed-pan before the time of leaving hospital. After the second stage of the operation toleration at night comes remarkably quickly and, except in the early stages, 'wet beds' are uncommon. Immediately after the operations, and for the first day or two, the urine seems to run away constantly from the anus, so much so that I often do not think it necessary to persist in keeping a catheter in the bowel, for the presence of such a foreign body in the anus is greatly resented.

When once toleration has been acquired it is very wonderful, for most of the patients can hold urine for several hours during the day, and nearly all night, without any discomfort. In the cases in which this could be ascertained, the average time was 3 hours. The longest was 4½ hours. All the patients state that though they have the desire to evacuate the rectum three or four times each day, they can contain the urine a good deal longer if circumstances demand it. Most of the patients get up once by night, and sometimes twice or even thrice. As a rule they waken without trouble, but *Case* 3, who has always had some incontinence by night, states that he empties the rectum quite involuntarily during sleep, and is not conscious that he has done so. On the other hand, *Case* 12 passes urine three or four times every night, but sometimes when very tired he does not get up to use the chamber, and a wet bed results.

The quality of the urine seems to have more to do with the toleration of the rectum than the quantity. When patients are suffering from 'renal attacks' and have presumably highly infected urine, they have great frequency, or even incontinence, though at ordinary times these same patients may have perfect toleration. When the patients are quite well the capacity of the bowel may be tremendous. For instance, on one occasion *Case* 1 held his urine as long as possible—i.e., from 9 a.m. to 1.15 p.m.—and then evacuated no less than 29 oz., which looks a formidable quantity in a Winchester quart! At one o'clock this boy had a meal, and just before he commenced to eat he said he felt anxious to empty the bowel; but the desire soon passed off, and he was able to wait in comfort until he had finished eating. Another patient (*Case* 3) held his urine as long as possible, and then voided 18 oz. The general health, quite apart from the question of renal infection, seems to have something to do with this question of toleration.

RECTAL FUNCTION AND CONTROL.

Usual amount voided at a time	5 oz.
Amount which can be comfortably retained ..	10 oz.
Maximum amount passed at any one time ..	29 oz.

Out of 10 cases, 7 have perfect control both day and night, and 3 have some incontinence at night only.

The problem of where the urine is actually stored in the bowel is of great interest. It cannot be in the rectum, for this part of the bowel is quite unable anatomically to contain the quantity of fluid which sometimes collects. In some of the cases submitted to sigmoidoscope examination, interesting information has been obtained on this point. On passing the instrument just within the sphincter, a small amount of urine escapes—2 to 3 oz.; but on advancing the instrument to examine the upper rectum, or lower sigmoid, a further and much larger quantity comes away; and as the higher reaches of the bowel are explored, still further amounts are evacuated. Post-mortem specimens showing enlargement and distension of the colon suggest that the whole of the large bowel may act as the reservoir. In *Case* 13, who was operated upon for the repair of the local defect two years and three months after the transplantation, the nurse who administered water per rectum was alarmed at the amount which easily flowed into the bowel by gravity. Unfortunately no accurate measurement was made, as the importance and interest of the point were not then realized, but she did observe that there was well over two pints. This boy unfortunately died, and his rectum and whole colon were filled, though not distended, with formalin solution in the preparation of the specimen, and for this purpose 1120 c.c. (39½ oz.) of the fluid were used. In *Case* 10, who also died, these observations were not made, but the colon was certainly more than usually capacious.

I have no facts to prove whether or not the fluid contents of the colon in these cases is absorbed, as has been assumed, but that is a matter which merits inquiry.

The anal sphincter, as tested by the finger, I have always found to be competent and alert, and that was so even in the case of a boy (*Case* 9) who was alleged to have loss of control, and who certainly had some slight anal prolapse at times. That the sphincter is more than usually active is proved by the fact that when these patients are placed under full anæsthesia the anus does not allow any escape of the rectal contents, and yet the passage of a catheter or the sigmoidoscope into the rectum demonstrates the presence of an ounce or two of fluid contents. When the latter instrument is used under anæsthesia and is passed a few times, the anus may become patulous; but in the absence of anæsthesia it remains on guard, and, from the story of the patients, without any effort so far as they are concerned.

Four of the patients state that they can pass flatus independently of evacuation, but nearly all the others expressed their inability to do so.

Sigmoidoscopic examination has been carried out both with and without anæsthesia. No special preparation has been used, and in every case, except for liquid contents, the bowel has been found empty of fæces and quite clean and healthy-looking. The mucous membrane is invariably moist and looks oily, but is otherwise normal. It does not seem to be unduly sensitive, and is capable of considerable air distension. The gradual filling of the instrument with liquid, and the constant steaming of the eyepiece by the warm urine, are new and interesting experiences. The search for the orifices of the ureters has not always been successful. Eight sigmoidoscopic examinations were made in seven patients, and one or both ureters were found in only four. In one patient (*Case* 5) both ureters were seen on one occasion soon after she had

recovered from an attack of renal infection, and the corresponding ureteric orifice was found pouting and bright red in colour. On another occasion, two or three years later, a painstaking examination entirely failed to discover either orifice!

In the post-mortem specimens which are available, two types of ureteric opening are demonstrated (*Fig.* 120). In the one the opening is funnel-shaped and is hidden beneath a fold of mucous membrane. In this type the area

FIG. 120.—*Case* 13. W. B. The recto-sigmoid, showing the entrance of the ureters in detail. The right is a small orifice not much larger than the bristle which is thrust through it, and is hidden under a fold. The corresponding kidney was dilated (*see Fig.* 106). The left ureteric orifice lies above a shelf in the bowel, and is like a rosette. It easily admitted a probe of $\frac{1}{16}$ in. diameter.

from which urine has trickled or suffused has been seen, but there is no definite spurt to indicate the actual orifice. The other type, represented by a sort of rosette, can be clearly seen and functions characteristically. As seen in the coloured drawings (*Figs.* 92 and 102), carefully made by Mr. Sewell from his own observation, these openings are on the summit of what looks like a polypus (*Case* 12), or more a cow's udder or the uvula (*Case* 3). When quiescent these excrescences hang flaccid, and are of a colour slightly pinker

than the surrounding mucous membrane; but when about to discharge urine they are seen to vermiculate, and then to retract, the extremity becomes irregular and pouts, and urine is discharged in a small spurt. In *Case* 3 the urine came from the side of such a uvula-like process, near its base, and not from the extremity. The discharge of urine appeared to be at about the normal rate and quantity, but I am not sure that this is necessarily an evidence of a normal ureter. In *Case* 9 the ureter, which had previously been implanted into the rectum by the Lendon-Peters method, was subsequently exposed on the floor of the ectopic bladder as the result of accidental injury during a plastic operation, and was seen to eject *clear* urine in spurts, but, on introducing a ureteral catheter, a quantity of *pus* was evacuated. At a subsequent operation, when this ureter was implanted into the bowel, it was found to be dilated almost to the size of the small intestine. So far as an isolated observation goes, this suggests that a dilated ureter may vermiculate and evacuate its contents at the normal rate. The intramuscular injection of indigo-carmine has not helped in the identification of ureteric orifices otherwise elusive. In *Case* 3, in which the ureteric uvula was first found, the blue effluent appeared at the normal time—seven minutes—and identified the site of the orifice very beautifully (*see Fig.* 92). The orifices which have been seen have usually been found just at the point at which the internal iliac artery causes a prominence in the bowel, and by measurement this was found to be about 8 in. from the anus.

The character of the evacuations is interesting. As a rule fæces and urine are intimately mixed, making up an offensive puddle with an indescribable odour. At other times the patient may void a soft, pultaceous stool, and sometimes, though rarely, a solid evacuation. At still other times the same patients will get rid of clear urine which has a decidedly offensive odour and contains an excess of mucus. On one occasion (*Case* 12) the patient, in the course of a three-hour morning, passed first 3 oz. of thick, pultaceous fæces, then 1 oz. of quite liquid mixed fæces and urine, and lastly 7½ oz. of turbid urine which deposited about 25 per cent of fæcal matter. Some of the patients always pass mixed fæces and urine, while others habitually void clear urine at one time and the mixed fæcal puddle at another.

None of the patients have complained of untoward irritation of the rectum, and the sigmoidoscope has not demonstrated the presence of proctitis, though this was found in a mild degree at the post-mortem in the two patients (*Cases* 10 and 13) who were confined to bed for some days before death. Possibly the excess of mucus which is always present exercises a protective action on the bowel wall. The rectum from *Case* 10, the boy who died from intestinal obstruction 3 years and 3 months after the ureter transplant, does show some thickening of all the coats, and the mucous membrane is covered with an inflammatory exudate (*see Fig.* 97). It must be remembered that this patient was very ill and confined to bed for a week before the specimen was taken.

At one time the patient W. K. (*Case* 3) was so much troubled with nocturnal incontinence that he always slept in a puddle. During this period the skin round the anus was sodden and whitened, resembling the skin of the abdominal wall around a suprapubic urinary opening.

WIDENING OF THE PELVIS.

Widening of the whole pelvis which results from the separation of the pubes is quite a striking feature which must not be overlooked (*see Figs.* 101 and 111).

A good many of these patients walk with a tendency to waddle, suggesting the gait of patients suffering from congenital dislocation of the hip. In one or two of the patients this has caused anxiety to the parents, but I have not known any complaints from the patients themselves, and they certainly appear to get sufficiently strong to enable them to carry out practically anything, just as normal children or individuals, and certainly this condition seems to be less noticeable and to give rise to less trouble as they grow older.

THE RENAL FUNCTION.

Judged by the standard of the general health, it may be said that none of the patients in this series shows definite evidence of gross renal insufficiency.

At the outset I must say I feel convinced that most of these patients develop some degree of ascending renal infection. This is borne out by the fact that in the two cases in which it has been possible to make post-mortem investigations there has been definite and gross evidence of its existence, in spite of the fact that during life neither of these patients suffered from symptoms indicating its presence.

Among the ten cases that are alive and well, and on which I have definite information on this point, there are three patients (*Cases* 8, 12, and 17) who, at 7 years, 3 years and 3 months, and 8 months after operation, have never suffered from any symptoms indicating renal infection. In *Case* 8 only one ureter has been transplanted.

Cases 1 and 2 have suffered from slight attacks of pain in one or other kidney region, with lassitude, possibly temperature, and frequent micturition, but these symptoms have never caused serious inconvenience.

Case 3 has suffered three or four times from a very definite kidney infection, and in one attack he was very ill with a high temperature (105°) and a tender left kidney.

Case 5 is the patient who, during her immediate convalescence, developed a perinephric abscess on the right side. In spite of this she has developed into a big, strong, robust girl, but she has on four or five occasions suffered from a recrudescence of infection, although in the intervals she has remained perfectly well. Since the Hunterian Lecture was delivered this girl has had another attack, and X rays show what is almost certainly a renal calculus on the right side.

Case 7, during immediate convalescence, suffered from intraperitoneal infection which probably originated about the site of the anastomosis, and though he has developed very well and is in very good health, he has at least twice suffered from febrile attacks of renal origin as shown by tenderness over the kidney regions.

Cases 9 and 15 refer to the same patient. This is the boy with one functional kidney with a greatly dilated ureter. After the intraperitoneal transplantation he had a smart attack of infection of the left kidney, and

three months later this was followed by a severe attack, ushered in by rigor and vomiting. His general health is good, and development is proceeding normally.

Case 10 was in remarkably good health until his death, which was due to peritonitis following an operation for intestinal obstruction. The peritonitis was the result of leaks in connection with an intestinal anastomosis. At the post-mortem examination both kidneys were found dilated, there was evidence of infection, and microscopically both interstitial and epithelial changes were found.

Case 12 probably suffered from some renal infection after the transplantation of the first ureter, but he made an entirely uninterrupted recovery after the second operation, and has exhibited no signs of renal infection since.

Case 13 was also particularly interesting, because he never showed clinical evidence of gross renal infection, but, on his death, which occurred two years and three months after transplantation, both kidneys showed marked evidence of ascending infection.

From these clinical observations it would appear that a moderate degree of renal infection is not inconsistent with average good health and well-being. It is to be remarked that, not only are these patients in good average health, but they stand up well to the trials of their ordinary environment. As the case records show, several of them successfully underwent operations under general anæsthesia without untoward symptoms. Further, *Case* 2 was not more than ordinarily upset by child-bearing and lactation. The fact that both the patients who died after operations subsequent to the transplantations (*Cases* 10 and 13) showed acute renal infection superadded to the gross and long-standing changes is not, in my opinion, any evidence that these patients were suffering in that way before their fatal illness. Mechanical drainage does much to minimize the effects of a chronic renal infection, and the fact that these patients were bedridden would in itself tend to allow the infection to run riot. Further, the acute exacerbation was probably more of the nature of a terminal outburst.

Chemical examination has only been carried out in a few cases, and the results, so far as they have been obtained, are set out in the following table :—

THE RENAL FUNCTION.

CASE	PERIOD SINCE OPERATION	PERCENTAGE OF UREA IN EVACUATION	BLOOD-UREA MGRM. PER 100 C.C.	AGE–WEIGHT–HEIGHT RATIO	GENERAL HEALTH
1	14 years	0·62	52	Below normal	Very good
2	13 ,,	1·5	27	,, ,,	,, ,,
3	10 ,,	1·5	34	Normal	,, ,,
5	5 ,,	0·6	—	,,	,, ,,
7	7 ,,	0·5	—	Below normal	,, ,,
8*	6 ,,	0·5	21	,, ,,	,, ,,
9	4 ,,	1·3	36	,, ,,	,, ,,
12	3 ,,	0·37	—	,, ,,	,, ,,
13	2 ,,	1·62	—	,, ,,	Rather thin and weakly

* Only one ureter transplanted.

Most of the patients are abnormally thirsty and drink copiously of water, and they state that the quantity evacuated per rectum bears a definite ratio to the intake. In three cases the total amount passed per rectum has been measured. V. K. (*Case* 5) passed 33 oz. in twenty-four hours. This was three years after the operation had been completed, and she was then 9 years and 8 months old. *Case* 9, a boy of 4 years of age, passed 44 oz. in twenty-four hours (*see Fig.* 119), and *Case* 10, a boy 10½ years of age, seventeen days after operation, passed only 25 oz. in the twenty-four hours. It is quite likely that more urine is passed as the renal organs become more accustomed to their altered condition.

ALTERNATIVE METHODS.

In this series of cases, with two exceptions, I have adopted the plan of intraperitoneal implantation of the ureter, largely based on the technique of Sir Harold Stiles. The Peters operation, or rather the Lendon-Peters operation, appeals to one because of its simplicity, and I believe it might have been attended by more success if it had been the rule to transplant the ureters by this method in two stages. But it is a method in which the operator has no opportunity of controlling the exact site of the anastomosis, and it can only be carried out in males. There are several cases on record in which the ureter has slipped out of the bowel, and in which, in consequence, an obstruction has formed which has interfered either with the immediate success of the operation, or with the subsequent utility of the anastomosis. This accident occurred in one of my cases (*Case* 14), and *Fig.* 109 illustrates exactly what was found post mortem. There are methods by which such an accident might be prevented, and these have sometimes been adopted, such as fixing the ureter by a stitch to the rectal wall, or fixing it by means of a catheter inserted into its lumen. Personally I much prefer the intra-abdominal method, which is under the guidance of the eye and can be more directly controlled in all its details. Of course, when available, the Lendon-Peters method can be employed in very young children, and should it prove a failure for any reason the intraperitoneal method can still be carried out at a later stage if the patient survives.

The most important recent contribution to this subject has been made by Robert C. Coffey, of Portland, Oregon, U.S.A., who has devoted very considerable attention to the transplantation of the ureters, and I am much indebted to him for keeping me informed of the progress of his work. In a series of recent papers he has drawn attention to improvements in the methods which have hitherto been employed. He first devised the plan of making the implanted ureters lie for a considerable distance in a submucous bed (*Fig.* 121), in the hope that the ureter would be compressed and temporarily closed by the pressure inside the bowel, thus preventing regurgitation of the bowel contents into the ureter itself (*Figs.* 122 and 123).

The next step consisted in the employment of ureteric catheters, which were tied into the ends of the ureters and were passed into the bowel, so that for ten days or thereabouts the secretion from the kidneys could be assured of a free passage without the temporary obstruction which sometimes arises as the result of œdema about the anastomosis.

The final problem which Coffey set himself to solve was the prevention of infection from the bowel lumen, and his latest technique (which has been described[8] since the delivery of the Hunterian Lecture) includes a method by which he attempts to sterilize the lower segment of the bowel before the

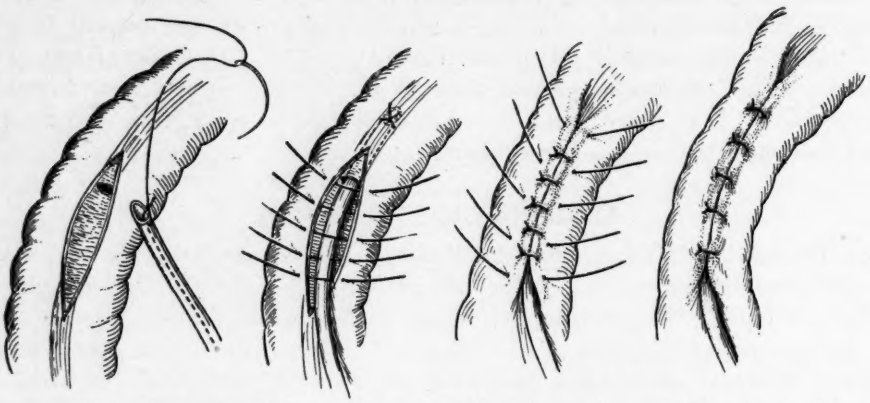


FIG. 121.—Shows the Coffey method of burying the ureter, and the catgut guide of C. H. Mayo.

implantation is carried out. Coffey has recorded the results of 9 cases operated upon by his completed technique. One patient was only 20 months old at the time of double implantation of the ureters for ectopia. This operation was carried out a year before publication, and the patient was in good health and without evidence of renal infection. The other 8 cases operated upon appeared to be equally satisfactory. His important papers should be carefully perused by anyone interested in this particular problem.

FIG. 122.—Coffey method.

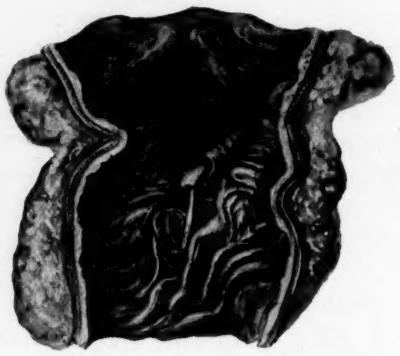


FIG. 123.—Stiles method.

Showing the result of operations carried out on the fresh cadaver. In both cases a fine wire has been passed through the ureter to demonstrate its orifice in the bowel.

Coffey's results have been so encouraging that, if extended experience in the hands of other operators bears out the work of the originator, then I have no doubt this operation will become the method of choice. In my

experience some degree of infection has occurred sooner or later, and I shall be surprised if any procedure can be devised which can prevent its advent in all cases. The catgut guide of Charles Mayo is probably an advantage, but on the other hand it may be that the submucous position of the ureter recommended by Coffey makes it much less likely to be obstructed in the earlier days.

Most workers have assumed that infection has been directly conveyed to the ureter by regurgitation of the bowel contents, but I believe that this is wanting in proof. In *Case* 13 it was not possible to make any fluid pass up the ureters from the bowel when this experiment was tried with the fresh parts just after death. In fact, in order to distend the ureters sufficiently for the purpose of setting up the specimen, it was necessary to pass a hollow needle into each separately. Yet in this boy both kidneys showed evidence of gross ascending infection. Possibly the infection reaches the ureters and kidneys by means of the ascending mucous currents described by C. J. Bond.[9] In my view it is essential to have an unimpeded opening into the bowel, and anything like obstruction, not even amounting to stricture, is more likely to bear a causal relationship to infection than any other factor. This view would bring it into line with other infections secondary to disease in the lower urinary passages.

THE SEXUAL PROBLEM.

At the outset I stated that the importance of the sexual problems associated with these deformities had early been brought before my notice. At that time it never occurred to me that the grosser forms of anomaly could be sufficiently rectified to restore the sexual functions, and it was with the idea of arresting development of the testicles that I excised portions of the vasa in my first three cases. At that time I was not aware that John Hunter had shown that division of the vas was not followed by atrophy of the testicle, and I am much obliged to Sir Cuthbert Wallace for pointing this out to me. The normal development of the patients whom I treated in this way has certainly shown that the sexual characteristics are not appreciably altered, but as yet I have no means of knowing whether their procreative functions have been arrested.

The general development and well-being of the patients here recorded encourages me to believe that reconstructive operations on the external genital organs may enable the victims to follow the dictation of their natural instincts. With the female patients there seems no barrier either to marriage or maternity, and the wide pelvis and separated symphysis render delivery easy.

AFTER-HISTORY OF SOME OTHER CASES NOT PREVIOUSLY PUBLISHED, AND FROM THE LITERATURE.

Through the kindness of Emeritus Professor Sir Harold Stiles, I am able to publish the after-history of some of his cases of transplantation of the ureters. I have further to thank Professor D. P. Wilkie, who kindly arranged to have the cases traced. This work was carried out by Mr. W. C. Wilson, of the Department of Surgery in the University of Edinburgh, to whom I am greatly indebted for the trouble he has taken on my behalf.

Case 1.—C. D., female. Epispadias. Operation in 1907 at age of 3. Reported well in 1913. At present (January, 1928) aged 23 years, unmarried; in constant employment as a dressmaker. General health excellent. Can retain for five or six hours during the day. Rises once at night to micturate. Very rarely some loss of control and slight escape of urine. Somewhat sensitive disposition.

Case 2.—A. McK., female. Epispadias. Right ureter transplanted. Operation in 1908, at age of 7. Perfect recovery. Seen 5¾ years later. No evidence of renal infection. Perfect control over urine, which she can retain for five to eight hours. Slight proctitis. Very well March, 1914, six years after operation. Not traced since.

Case 3.—R. G., male. Extroversion of bladder. Transplantation of both ureters into pelvic colon, November, 1911, at age of 3. The child made an excellent recovery from operation. The boy died on June 22, 1927, at the age of 19 years. Control of urine seems to have been entirely satisfactory, and apparently there was no complaint referable to the operation. He never showed any signs of puberty. The voice did not break, and at death he was only 3 ft. 6 in. in height. In appearance and development he was as a child of 7 or 8 years. The case-notes state that both testicles were descended. For years before death he suffered from periodic attacks of 'cyclic vomiting'. Death occurred in one of these attacks. The terminal illness was apparently marked by convulsions, and according to the doctor it was a very typical attack of cyclic vomiting.

Case 4.—E. S., female. Epispadias. Operation in 1913 at age of 3. At present (January, 1928) aged 18 years; unmarried. Employed as cakebaker. Condition does not interfere with employment. General health has been uniformly good since operation, and is at present excellent. Can retain urine for five to six hours. Sometimes suffers from lack of control during the night; otherwise perfect control. Is contemplating marriage.

Case 5.—A. S., female. Extroversion of bladder. Right ureter transplanted into the pelvic colon, June, 1919. Left ureter November, 1919, at age of 5. Made excellent recovery from both operations. For some three or four years afterwards there was occasional leakage of urine from the bowel by day and every three or four hours at night. Could retain urine for a maximum period of five hours. During these years occasional attacks of mild general systemic disturbance with pain in left kidney region and diminished urinary excretion. For the past five years condition has gradually improved in respect of control, and the attacks of pain, etc., have become much less frequent—now about one in a year. Now, January, 1928, nearly nine years after operation, is of slight build and sensitive disposition. General health excellent. Occasional slight lack of control. Passes urine (with fæces) every two hours by day and rises once during the night. Can retain urine for five hours fairly easily.

Case 6.—J. N., male. Epispadias. Age 7 at time of operation. Previous to this had undergone numerous operations on neck of bladder with no success in establishing any control. Right ureter transplanted January, 1920 (technique modified in that opening of ureter was enlarged by longitudinal incision). Ureter came adrift from bowel about a week later. At further operation (April 24) ureter could not be brought down to pelvic colon, and a fistula was made to anterior abdominal wall. To relieve this condition the right kidney was removed on Oct. 25. Further operation not advised. Patient brought back four years later and earnest request made for operation, since life with incontinence was proving unbearable. Left ureter transplanted May 16, 1924 (by Coffey method). No urine passed after operation. Died in uræmic convulsion on May 21.

Mr. Robert Purves, of Lincoln, operated upon a case by the method of Stiles, and he has very kindly sent me the following notes together with the after-history.

J. W. L., male, age 31, was admitted to the County Hospital, Lincoln, on Oct. 22, 1922, for ectopia vesicæ and epispadias. The patient stated that he had always passed urine through the abdominal wall, and that, being continually wet, he had suffered very much from excoriation of the skin, which had rendered him less and less able to get about, so that he had been confined to his bed for the past twelve years.

His condition on admission to hospital was that of a frail, anæmic man. There was marked pyorrhœa, and much deformity from his prolonged residence in bed in a faulty attitude. The left hip was flexed 120°, externally rotated and abducted. The knee of the same side was flexed 100°. The right hip was also flexed to a like extent, internally rotated and adducted, and the corresponding knee was flexed to a slightly less extent. The whole spine was curved antero-posteriorly, and also to the left, the costal margin

touching the iliac crest. Both abdominal recti muscles were correspondingly contracted. He had a well-marked ectopia vesicæ with complete epispadias. The skin surrounding the bladder and that of the groins was much excoriated, with marked proliferation of the epithelium. This skin and the mucous membrane of the bladder were very sensitive. X rays showed failure of fusion of the pubic arch. The testicles were normally descended, and there were no signs of any other congenital deformity, while he was said to be sexually fully developed.

It was decided to treat the condition by transplantation of the ureters after the method of Stiles, and on Oct. 24, 1922, he was put on a mixture containing urotropine and acid sodium phosphate, by way of preparation. Two days later the right ureter was transplanted into the pelvic colon through a right rectus incision. The patient passed urine per rectum the morning after the operation. Four days later, on Oct. 30, he was given a pill of methylene blue, and the colour was well exhibited in the motions. Urine was passed per rectum at two-hourly intervals during the day, and every four hours during the night. A few days later he was able to go as long as four hours during the day, and during the night he was only disturbed twice. In another week the day period had increased to five hours.

On Nov. 15, twenty days after the first operation, the left ureter was transplanted. There was considerable difficulty in approach owing to the contracted condition of the left rectus. The right ureterocolic anastomosis was found to be sound, and no adhesions were encountered. Five days later the patient was passing urine per rectum four-hourly during the day, and a fortnight later he was able to hold his urine in the rectum as long as four and a half hours, but he had some incontinence.

All his teeth were extracted three weeks after the second operation, and on Feb. 14, 1923, he was discharged from the hospital. He had good control of the urine, but there was much moisture from the exposed mucous membrane of the bladder. As this moisture was coloured blue after the exhibition of methylene blue, the presence of a third ureter suggested itself.

Three and a half months later, on May 28, the patient returned to hospital for treatment of the ectopia and epispadias. He occasionally had some urine passing through the bladder, but was dry for more than a week at a time. Urine was being passed per rectum three-hourly. Three days later, on May 31, the posterior wall of the bladder was freed all round except for a pedicle below. The mucous membrane of the floor of the urethral furrow was divided from the skin margin of the penis, and the bladder wall was turned down and sutured to the edges of the urethral mucous membrane so as to form a roof to the urethra. The skin edges of the abdominal and penile wounds were then united each to each. Six days later the patient passed some urine through the new urethra. The abdominal wound had given way a little at the upper extremity, but was granulating well, and he was discharged on June 21. He refused to have any treatment for the correction of the deformities of the legs, but their positions were somewhat improved from those present on his first admission.

Two years later Mr. Purves visited this man at his home. He had complete control of the rectum, with evacuation every four to four and a half hours, and had then been dry for twelve months. He was getting about well with crutches, and frequently rode several miles on a bicycle. He had started work as a boot repairer. Though still very pale, he was fatter and much healthier-looking than before.

NOTE.—Dr. E. Barry Denny reported that J. W. L. died of pneumonia on Nov. 21, 1925, after six days' illness. No evidence of renal infection was observed then or previously. There was no post-mortem examination.

Through the kindness of Mr. Lawford Knaggs I am able to append the following note on the subsequent history of an adult female, whose case was fully and most carefully recorded by him[10] under the following title: "On Implantation of the Ureters into the Rectum by the Sacral Route, Illustrated by a Case of Inveterate Vesico-vaginal Fistula in which the Left Ureter was Implanted and the Right Kidney Removed".

The patient, 42 years of age, was admitted to the Leeds General Infirmary in February, 1909. Five years previously, during a difficult confinement, she was so much torn that the bladder and vagina were converted into a single compartment. For the cure of her miserable condition she had submitted to thirteen operations before she came under the care of Mr. Knaggs.

This surgeon gave very careful consideration to the case, and finally worked out a plan for implantation of the ureters by the sacral route. On account of the extraordinary amount of scar tissue only one ureter could be dealt with as intended, and subsequently the

opposite kidney was removed. Eventually the patient made a complete recovery and went to her own home. Seven months later she reported herself as very well and able to retain urine for about three hours. Sometimes at night there was a little incontinence if she happened to sleep unusually soundly. Three years later she was again in hospital for the treatment of a prolapse of the exposed mucous membrane of the bladder through the vesico-vaginal fistula. This was corrected by plastic operations. In October, 1927—that is, eighteen years after the implantation of the ureter—she reported herself as very well, with no pain or bad effects from the operations, and able to work well looking after her own house. At no time have there been any symptoms suggesting infection of the kidney.

In 1909 Sir Arthur Ball,[11] of Dublin, recorded the case of a boy 5 years of age, the victim of ectopia vesicæ, upon whom he had operated in July, 1908. The ureters were implanted into the rectum by the Lendon-Peters method, and subsequently the mucous membrane of the bladder was removed. Sir Arthur very kindly traced this patient for me, and he reports that now, twenty years after the operation, he is still well and strong, with good rectal control, and able to earn his own living.

The following statistics have been extracted from one of the latest papers on the subject from the Mayo Clinic.[5] I have often discussed the matters under consideration with Dr. Charles Mayo, and I am much obliged to him for several personal communications, and especially for his kindness in drawing my attention to the valuc of the catgut urine guide.

MAYO CLINIC STATISTICS.

From 1901 to April 1, 1926:—

71 *Cases operated upon*—

Plastic operations only	8 cases
Transplantation of both ureters	46 „
Transplantation of one ureter	10 „
Exploration only	2 „
Moynihan's operation	2 „
Coffey's operation	3 „

11 *Deaths from operation* (16·6 *per cent*)—
5 from peritonitis, 4 from septic kidney, 2 from renal insufficiency.

7 *Late deaths*,
2 months to 12 years after operation. Only 1 due to renal complication.

29 *Ureter transplants reported as to after-results*—
25 satisfactory, 2 poor control, 1 has incontinence.
These patients are alive and well from 1 to 15 years after operation.

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SHORT NOTES OF RARE OR OBSCURE CASES

A CASE OF HÆMATURIA ARISING FROM ONE SEGMENT OF A DOUBLE KIDNEY, TREATED BY RESECTION.

By ARTHUR JACOBS,

SURGEON TO OUT-PATIENT DEPARTMENT AND UROLOGIST, GLASGOW ROYAL INFIRMARY.

The following case appears to be worth recording:—

Miss B., a woman, age 40, was admitted to Glasgow Royal Infirmary with a history of continuous hæmaturia of five months' duration. The bleeding was unaccompanied by pain, colic, or other urologic symptoms, and the general examination was negative. The urine was deeply blood-stained, contained no casts, and was sterile. On cystoscopy two ureteric orifices were observed on the left side, situated on a common ureteral ridge. The efflux from the outer and higher orifice was deeply blood-stained, whereas that from the inner and lower one and also that from the right ureteric orifice were clear. An estimation of the renal function by the indigo-carmine test revealed no impairment, a strong blue efflux appearing at the three ureteric orifices within four minutes of intravenous injection.

Fig. 124.—Bilateral pyelogram. The upper and inner pelvis on the left side is nearly empty. The lower and outer one is normal in appearance. On the right side the pelvis is of the bifid type.

Subsequently the three ureters were catheterized, and a pyelographic examination was carried out: the right pelvis was first distended with the opaque fluid, and immediately thereafter the two pelves on the left side were filled. After taking the pyelogram (*Fig.* 124) it was found that the upper and inner left pelvis had almost evacuated its contents; this was therefore distended once more, and another X-ray photograph taken (*Fig.* 125). It will be seen that the two pelves on the left side are completely separated from one another and occupy different levels. The superior and inner one

is the smaller, and practically consists of two calices; the lower and outer pelvis is normal in appearance; that on the right side is of the bifid type. The examination thus showed that a complete reduplication of the pelvis and ureter existed on the left side, and that the source of the hæmaturia was confined to the lower portion of that kidney, although the cause of the hæmaturia was not made apparent. As no spontaneous diminution in the bleeding was observed, it was decided to resect the affected portion.

OPERATION.—The kidney was exposed and delivered through a curved lumbar incision. A shallow groove was observed in the kidney proper, passing from the lower part of the hilum in front to the convex border just below its mid-point. The groove was not continued on to the posterior surface. The resection was commenced by ligating and dividing the vessels running to the lower part of the kidney. The lower segment was then separated from the upper by an incision which was made to pass through the groove mentioned above. The outer ureter was next divided, and the lower segment removed. There was surprisingly little hæmorrhage from the cut surface of the upper segment, and it was readily controlled by deep mattress sutures, which were passed through the kidney substance. A rubber-tube drain was placed below the cut surface of the kidney and brought out through the upper angle of the incision, which was then closed.

FIG. 125.—Skiagram taken after the upper and inner pelvis had been refilled.

AFTER-HISTORY.—The hæmaturia disappeared within twenty-four hours of the operation. Some considerable leakage of urine took place through the tube during the four days that it was allowed to remain in position, and after removal of the tube this continued through the opening which had been left at the upper end of the wound. The rest of the wound healed by first intention. The patient was sent to the convalescent home three weeks after operation, by which time the leakage had almost ceased. She returned to hospital two weeks later, however, with a profuse urinary discharge. This was again confined to the original drainage opening, the rest of the wound having remained intact. The patient was re-admitted, confined to bed, and put on urinary antiseptics. The discharge ceased and the fistula closed in ten days. An indigo-carmine functional examination was then carried out, and within four minutes of intravenous injection a strong blue was observed coming from the left inner ureteric orifice and also from the right one. There was no recurrence of the hæmaturia.

PATHOLOGICAL FINDINGS.—For the following account of the findings in the resected portion of the kidney (*Fig.* 126) I am indebted to Dr. Helen Wingate.

Ward Specimen No. 1914. *Lower Half of Left Kidney.*—On splitting the portion of kidney removed, a small area of hæmorrhage is evident at the apex of one of the calices, and its appearance suggests the presence of an angioma. Microscopic examination, however, proves it to be an interstitial hæmorrhage, associated with a considerable round-celled infiltration. The renal parenchyma shows early chronic changes. These are well-marked in the glomeruli, some of which are swollen and adherent to Bowman's capsule, while others

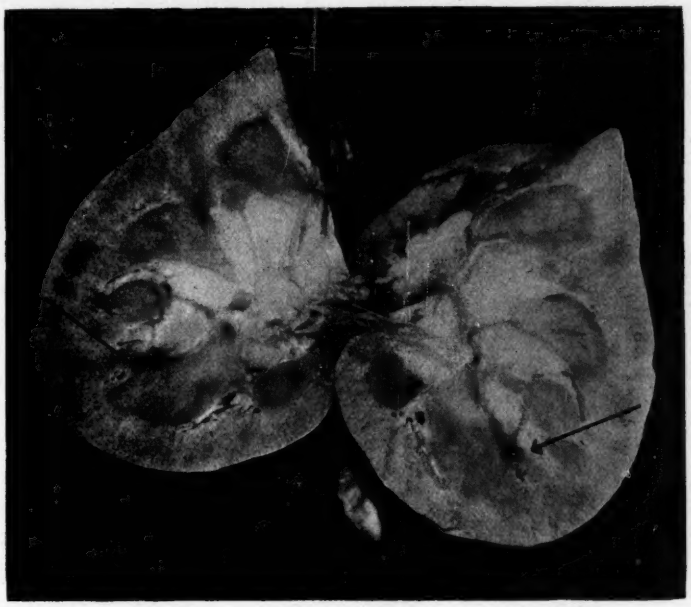

FIG. 126.—Photograph of the resected portion of the left kidney. The arrows point to the area of hæmorrhage, which is immediately adjacent to a calix. The macroscopic appearance suggested a hæmangioma.

show commencing fibrosis, and a few are comparatively fibrous. In many cases Bowman's capsule is thickened, and in some cases hyaline. The tubular epithelium shows intense cloudy swelling and some catarrh. The renal vessels are unduly thick.

Comment.—Chronic nephritis may be present without there being any clinical evidence of that condition. Probably in many cases it is the underlying cause of so-called 'idiopathic or essential hæmaturia', and should be suspected in a case of hæmaturia if no other cause for the bleeding can be ascertained after a complete urologic investigation. Long-continued hæmorrhage may necessitate nephrectomy to save the patient's life. In this case, as the result of the pre-operative investigation locating the source of the hæmaturia to one segment of a double kidney, it was possible to plan a conservative operation and to remove only the offending portion of the organ.

CONGENITAL DIVERTICULUM OF THE STOMACH IN AN INFANT.

By NEIL SINCLAIR,

SURGEON TO THE EVELINA HOSPITAL FOR CHILDREN, LONDON.

THE following case seems worthy of record :—

In May, 1928, a male infant, age 4 months, was admitted to the Evelina Hospital with symptoms suggesting intussusception—that is, vomiting and the passage of blood by rectum. For five weeks the child had attended the out-patient department for wasting and constipation. The vomiting and passage of blood had been present for only a few hours before admission ; the vomit from time to time contained bright blood in small quantities. The child's general condition was poor, and considerable wasting was present. A small rounded tumour was felt in the left upper abdomen and was also palpable by a finger in the rectum.

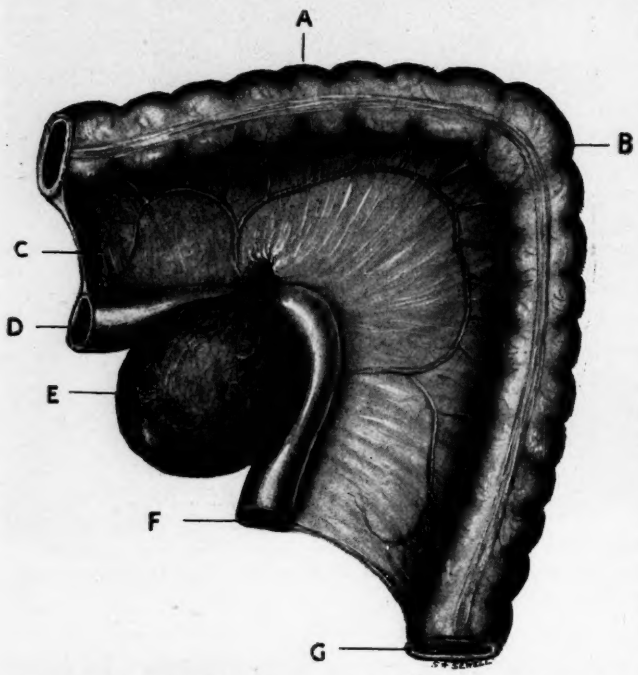

FIG. 127.—Relations of tumour as found at operation. A, Transverse colon thrown back; B, Splenic flexure; C, Transverse mesocolon; D, Duodenum; E, Tumour; F, Jejunum; G, Descending colon.

At operation performed the same day no intussusception was found, but from the region of the duodenojejunal flexure protruded a globular tumour, a little larger than a golf ball (*Fig.* 127). This was plum-coloured and tense, and had a short but well-defined pedicle which passed above the duodenojejunal flexure and was attached intimately to the under-surface of the transverse mesocolon just above the flexure. Its surface was covered by a thin vascular film of peritoneum apparently derived from the mesocolon. The pedicle did not appear to be attached to the colon, duodenum, pancreas, or stomach, all of which were carefully examined. The tumour was opened : its wall was thick and deeply congested and its cavity contained dark blood and mucus. A thick rugose mucosa was present. The pedicle, though not apparently twisted itself, was very intimately connected with the mesocolon, which seemed to be constricting it. Owing to the poor condition of the child it was not deemed advisable to trace the pedicle

further by dissection; it was accordingly divided and the stump oversewn. No lumen was visible while this was being done. The colon, duodenum, pancreas, and stomach were all again examined and appeared normal. Operation shock was severe, but the child made an uninterrupted recovery, and was, some eight months later, well and strong.

Naked-eye examination of the tumour afterwards showed a globular sac with well-developed muscular coat and a thick mucosa resembling that of the stomach. Opposite the pedicle on the inner side was a depression from which a fine probe passed easily into the pedicle. Further examination of the pedicle confirmed the impression formed at operation that no twisting had occurred.

A month after operation the child was given a barium feed and the stomach was X-rayed by Dr. Henderson, Radiologist at the Evelina Hospital; the radiographs show an apparently normal stomach.

Microscopic sections made of the wall of the tumour by Dr. Elworthy, Pathologist to the West London Hospital, and by Mr. T. P. Lawrence, of the Royal College of Surgeons Museum, show that its structure is identical with that of normal stomach (*Fig.* 128). Oxyntic cells are present. The specimen is preserved in the Museum of the Royal College of Surgeons.

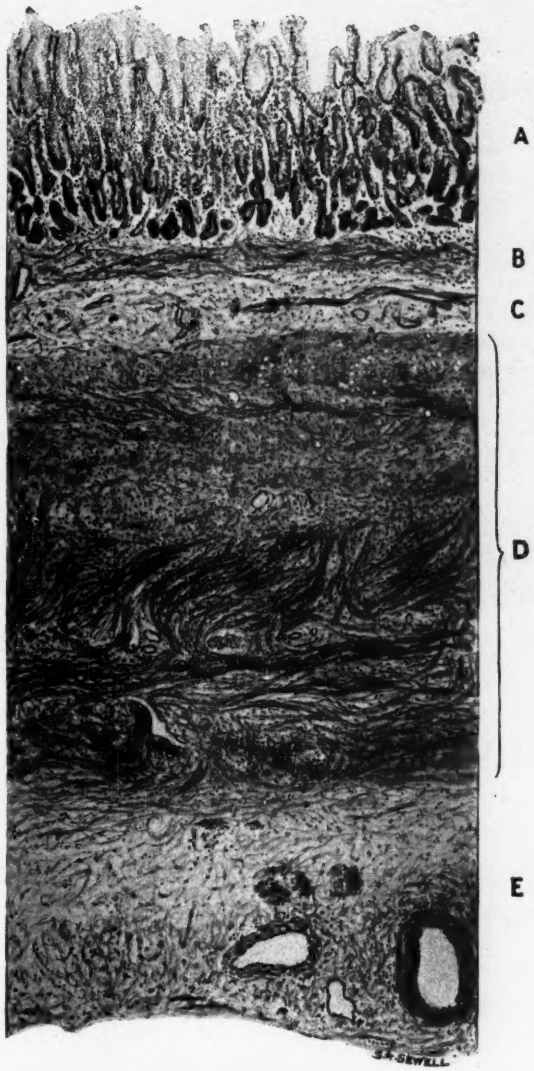

FIG. 128.—Microscopic section of tumour. A, Mucous membrane; B, Muscularis mucosæ; C, Submucous layer; D, Transverse muscle with fibrous tissue; E, Subperitoneal tissue.

I am indebted to Sir Arthur Keith for the following remarks on the condition:—

"1. As to the nature of the cyst there can be no doubt; it reproduces the exact structure of the stomach and therefore one infers it arose from that organ.

"2. There was no food in the cyst, therefore its lumen had no open communication with that of the stomach.

"3. A diverticulum arising from the dorsal border of the stomach, during the second month of development would be included in the dorsal

mesogastrium, where it would lie near or beside the pancreas, and when the omental sac is developed would come to be in the posterior wall of that sac. I infer that the cyst described here has arisen thus.

"It is clear that the circulation of the cyst became obstructed in some way and a state of threatened gangrene set in. The symptoms of obstruction were apparently of reflex origin; when the cyst was removed they disappeared. I have not come across such a specimen as this before, but I know records of such have been made—although they are rare."

CONCLUSIONS.

1. The specimen appears to be one of true congenital diverticulum of the stomach. It was not possible at operation or by subsequent X-ray examination to determine its exact site of attachment to the stomach.

2. The symptoms which led to operation were presumably due to an increasing constriction of the pedicle by the transverse mesocolon through which the diverticulum had passed (or around which the mesocolon had developed).

3. There was no evidence of torsion of the pedicle.

A CASE OF OSTEOMYELITIS OF THE SPINOUS PROCESS OF A DORSAL VERTEBRA.

By S. J. HARTFALL and L. B. HESELTINE,

THE GENERAL INFIRMARY, LEEDS.

The case reported is one of considerable interest, illustrating the difficulties of diagnosis in a condition of acknowledged rarity yet of gross pathology as revealed at autopsy.

History.—The patient, a boy, age 8 years, was admitted to the Leeds General Infirmary with the following history. He was quite well until three days before admission, when, shortly after bathing in the sea, he complained of a dull pain in the middle of the back, and vomited bilious material. Both symptoms continued for two days, and on the third day a doctor was consulted. He diagnosed '? meningitis' and advised admission to hospital.

On Admission.—On the day of admission the vomiting ceased and did not recur. The child's temperature was 101°, pulse 132, respirations 36. He lay perfectly still and looked acutely ill. His mental condition was quite normal; he answered questions intelligently and promptly. The face was flushed a little and somewhat expressionless. There was no headache, squint, or ocular disturbance of any sort, but there was notable rigidity about the neck, and Kernig's and Brudzinski's signs were positive. No sensory changes were present, tendon reflexes were normal, and the plantar reflex was flexor. The only other obtrusive feature was the intense hyperæsthesia which seemed to extend over the whole length of the spine and was maximal in the lower

dorsal and lumbar regions. The skin and subcutaneous tissues in this situation appeared normal.

A lumbar puncture was performed; the fluid was under slightly increased pressure and of a faint turbidity. Cytological examination showed slight excess of cells, which were polymorphs. No growth was obtained on culture. A radiograph of the spine was negative.

Subsequent Course.—The child's condition grew steadily worse; there was a persistent remittent and intermittent temperature, opisthotonos, and spinal hyperæsthesia so extreme that he could not bear to have his back touched, and cried out if the cot were jarred.

A second lumbar puncture was attempted; only a few drops of yellowish fluid were obtained, however, again with excess of polymorphs. Further attempts at lumbar puncture were made, but never was fluid obtained.

On the seventh day of the illness the temperature stood at 103° and the child became delirious for the first time; the back arched almost to a semicircle. Towards night it became obvious that the patient would not survive many hours. He died early in the morning, the temperature rising to 107°.

Post-mortem Findings.—On incising the muscles on either side of the spinous processes in the dorsal and upper lumbar region, thick yellow pus escaped in considerable quantities. It appeared to be occupying the fascial spaces between the various muscles composing the posterior spinal group, and seemed to originate from the region of the 6th dorsal spine. Further dissection revealed this process and its laminæ stripped bare of periosteum and having a dead white appearance, in marked contrast to the processes above and below it. The tip, on its lower edge, was eroded and the bone here was soft, and crumbled on scraping with a knife. By pressure pus could be made to exude from the spinal canal through the interlaminar membrane (ligamentum subflavum) above and below the affected vertebra.

On removal of the spinous processes by sawing through the laminæ, the spinal dura was found to be firmly attached to their inner aspects and was congested, rough, and perforated at one or two points, while the ventral portion of the dura was free, entirely unattached, and not obviously inflamed. Thick yellow pus was found to occupy the whole length of the spinal canal from bulb to cauda equina. The bodies of the vertebræ were healthy. The brain and membranes appeared normal and there was nothing of interest elsewhere. Films of the pus showed numerous staphylococci, and on culture a pure growth of *Staphylococcus aureus* was obtained.

We are indebted to Dr. W. Vining for permission to publish this case.

REVIEWS AND NOTICES OF BOOKS.

The Art of Surgery: A Text-book for Students and Practitioners. By H. S. SOUTTAR, D.M., M.Ch. (Oxon.), F.R.C.S. (Eng.), Surgeon to the London Hospital. Crown 4to. Pp. 624 + viii, with many illustrations, some in colour. 1929. London: William Heinemann (Medical Books) Ltd. 30s. net.

WHETHER surgery is an art or a craft is a debatable point. Perhaps the truth is that, as in many other vocations, it is a combination of the two that produces the ideal. Add to the perfected skill of the craftsman the imagination and breadth of view of the artist and we have a man capable of steering the ship of knowledge into unexplored waters and of charting the way so that others may follow.

Mr. Souttar's *Art of Surgery* strikes us as the work of a craftsman rather than of an artist. He has set out to lighten the burden of the student by omitting what is not essential and describing very fully what is fundamental. We can hardly say that in this he has entirely achieved his object, for he has tended in places to give details at the expense of fundamentals. There are thirteen pages on cerebral tumours alone, while the whole of cerebral and head injuries is dispensed with in a matter of ten pages.

The system of marginal illustrations by line drawings has much in its favour, as it avoids breaking up the text and diverting the reader's attention. The majority of these drawings are self-explanatory, but some, we feel sure, will convey but little to the student, and those on hernia he will find perplexing. The four marginal sketches on page 245 have puzzled us in endeavouring to interpret them. The section on diseases and injuries of nerves is excellent and the drawings are good, but surely a detailed account of the injection of the Gasserian ganglion for trigeminal neuralgia is superfluous.

There are a number of references to comparatively rare conditions, such as the gravitation paraplegia of Thorburn and Mikulicz's disease, while there is no mention of spinal shock or mixed parotid tumour. In a book of this nature the author is bound to be dogmatic, so that the practising surgeon may not find himself in agreement with all the statements made; but to the student just beginning the study of a subject, dogmatism is infinitely preferable to a confused mass of theories, the truth or otherwise of which he has no opportunity of testing. However, few will agree with Mr. Souttar when he says that in the absence of a palpable tumour the case is probably not one of intussusception; that diaphysectomy in osteomyelitis is often necessary; or that the operative treatment of congenital dislocation of hip is seldom successful. The section on the abdomen is simple and well balanced; but we would impress on the student that fæcal vomiting is rather a sign of impending death than of intestinal obstruction.

We have the impression that Mr. Souttar has aimed at originality and uniqueness, and we congratulate him on his success in this; but we think that Billroth's description of tuberculous granulation tissue as being like 'ivy on a wall' is preferable to the author's 'lichen on a stone'.

The student will find the book pleasant and easy to read, and he will be the better for its perusal, covering as it does the main facts of the subject. We cannot say that it will supplant his usual text-books, but he will find it a useful introduction to the subject.

Surgery in the Tropics. By Sir FRANK POWELL CONNOR, D.S.O., F.R.C.S., D.T.M. and H., Lieut.-Col. I.M.S., Professor of Surgery, Medical College of Bengal, Calcutta, and Surgeon to the College Hospital. Post 8vo. Pp. 293 + ix, with 99 illustrations. 1929. London: J. & A. Churchill. 12s. 6d. net.

SURGERY in the tropics necessitates a knowledge not only of those surgical diseases and their complications which are rare elsewhere, but also of the modifications which general surgical methods must necessarily undergo to adapt themselves to the peculiar features of tropical environment. It is to the former that the author has almost entirely devoted this book of 300 pages, although he foreshadows the possibility of a future opportunity of directing attention to the latter. He points out that the steadily increasing use of aerial transport, with its rapidity of travel, is likely greatly to extend the area in which 'tropical' diseases will be encountered in the future; it will then be necessary for all medical students to receive instruction therein. The author is to be congratulated on having been able to describe so many tropical diseases within his restricted space, though doubtless opinions will vary as to whether the best possible apportionment has been obtained. The important subject of plague is very summarily dismissed, whereas an excellent account is given of liver abscess and its treatment, stress being laid on the great change of outlook that has resulted from the introduction of emetine.

Errors are very few, though on page 88 'ileo-sigmoidoscopy' should read 'ileo-sigmoidostomy'. This book should be studied by all those who intend to practise in tropical regions.

Neurosurgery: Principles, Practice, and Treatment. By WILLIAM SHARPE, M.D., Professor of Neurosurgery, New York Polyclinic Hospital and Post-graduate Medical School, etc.; and NORMAN SHARPE, M.D., Attending Neurosurgeon, St. Mark's Hospital and Hospital for the Ruptured and Crippled. Medium 8vo. Pp. 762 + xxxvii, with 208 illustrations in black-and-white, and 5 in colours. 1928. London: J. B. Lippincott Co. 42s. net.

THE presentation of a large volume devoted to the problems of neurosurgery testifies eloquently to the growing importance and complexity of this particular specialty. Within these lavishly illustrated pages the authors deal with the theory and practice of the surgery of the brain, the spinal cord, and the peripheral and cranial nerves; the surgery of the sympathetic system is not considered. It must be confessed, however, that this presentation of neurosurgery falls very short of the ideal, and despite its length, cannot be considered as an exhaustive—or even adequate—monograph. Clinical and pathological details of brain tumours are treated very sketchily, though the authors give a useful discussion on the so-called 'pseudo-tumour' or 'wet-brain'. The chapters on cranial injuries are good, and the value of spinal manometry is emphasized as an early indication for operation. "Chronic brain injuries" are well discussed, and it is shown that two-thirds of a series of patients discharged from hospital with the diagnosis of fractured skull in the decade 1900–10 subsequently showed persistent cerebral disturbance. Brain trauma in infancy is next discussed, but its importance in the etiology of Little's disease is probably exaggerated. The chapters on spinal tumours are good, and it is interesting to note that the dangers of lipiodol as a routine diagnostic aid are stressed. But when we read that "no unfavourable case-reports have been found in the literature" we are shown merely the inadequacy of the authors' search. There is some confusion of thought expressed in the paragraphs on the chemistry of the spinal fluid, especially where it is stated that in regard to albumin "its presence in the normal fluid has been disputed by some; at any rate it is present only in minute quantity."

Most British surgeons and neurologists—while agreeing with the authors in their praise of resection of the sensory root of the Gasserian ganglion for trigeminal neuralgia—will profoundly disagree with their condemnation of alcoholic injection into the ganglion as a therapeutic measure. Nor will they subscribe to the authors' operation of peripheral neurectomy for trigeminal neuralgia localized to one division. Treatment of general paralysis by the intraventricular injection of salvarsanized serum is described, and details are given of the authors' experimental work with the introduction of dyes into the cerebrospinal circulation of animals. The most

extraordinary and indefensible point of all, however, is that the authors advocate laminectomy as a deliberate form of treatment in cases of disseminated sclerosis. To argue that marked improvement has followed such measures means nothing to those with experience of this disease. No reference is made in this book to the operation of chordotomy or to the treatment of intractable pain and gastric crises by spinal ramisection.

Ulcères de l'Estomac et du Duodénum. By VICTOR PAUCHET, GABRIEL LUQUET, and A. HIRCHBERG. Crown 4to. Pp. 354, with 309 illustrations. 1929. Paris: Gaston Doin et Cie. 13s. 9d.

VICTOR PAUCHET has the gift of exposition and commands the services of an artist whose pen technique is extraordinarily striking in its beauty and effectiveness. The usual arrangement of a work such as this has been reversed, in that the operative details and clinical management of patients are considered first, this part being written in association with Luquet, the pathology and etiological considerations being left for Part II. This is rather unfortunate because it is apt to magnify the place of surgery in the treatment of gastric ulcer, whereas all thinking clinicians are coming to look upon surgery, essential as it is, as only a necessary temporary phase in the evolution of medicine. Starting from this basis the surgeon is free to lay down rules for the conduct of cases where medicine now fails. M. Pauchet is dogmatic but logical in his recommendations. He states that only one method of suppressing hyperchlorhydria is known—namely, a large pylorogastrectomy—and he sees in this fact the only pointer to effective treatment of ulcers of the stomach or duodenum associated with excess of acid. He declares himself for this reason a partisan of resection *à outrance* in ulcer. Rightly he says it is no argument against resection that the operation is difficult. He disposes of the mortality argument by comparing his own mortality of 4·9 per cent for gastrectomy with that of hysterectomy for myoma, which is the same and is not usually considered a very serious procedure.

Gastrojejunostomy, Balfour's operation, annular gastrectomy have all been found unsatisfactory in his hands. Whenever possible he performs pylorogastrectomy for ulcer of the duodenum when accompanied by hyperchlorhydria, and always for gastric ulcer from fear of cancer supervening. For duodenal ulcer with low acid content he performs a simple gastrojejunostomy. The descriptions of difficult gastrectomy and duodenectomy operations are admirably clear. To get free access, he seems prone to make an L-shaped incision of the abdominal wall without hesitation.

With regard to post-operative hæmorrhage as a complication of gastric surgery, the interesting statement is made that if gastric lavage and a blood transfusion do not suffice to stop it, any attempt at re-opening the abdomen and active hæmostasis is doomed to failure. The author says that in such circumstances there is nothing to do but stand by and watch the patient die.

In the section on the treatment of hæmorrhage from the ulcer itself the logical course is recommended of operating to remove the ulcer as soon as and whenever the condition of the patient will allow. But it is not easy to understand quite how this decision is to be made. Pauchet brings forward again his view that very severe and fatal poisoning from the absorption of the products of digestion of the patient's own blood takes place, so that after removal of the ulcer it is necessary to wash out the contents of the colon, for which a cæcostomy is most effective.

Part II is written by Hirchberg. It reviews the pathology and anatomy of ulcers of the stomach and gives numerous statistics. It is a satisfactory account on ordinary lines. This book and its companion volume on gastric cancer already reviewed in our pages are two attractive works on gastric surgery.

Chirurgie de l'Estomac et du Duodénum. By HENRI HARTMANN, Professor of Clinical Surgery, Paris. Part II (7th Series of Works on Surgery). Imperial 8vo. Pp. 340, with 142 illustrations. 1928. Paris: Masson et Cie. Fr. 60.

THIS book is a collection of chapters on the surgery of the stomach and duodenum, some of which are written by Professor Hartmann and some by his assistants at

the Hôtel-Dieu, Paris. Although the material is good throughout, probably the most instructive part of the book is the large number of cases which are quoted in connection with each section and which are followed up, in some cases for many years, after operation. It is from a consideration of the after-results that the discussion on treatment is based, and, as might be anticipated, it is highly instructive. There is a particularly detailed discussion of the chronic gastric ulcer, its microscopical appearance, and the question of its being the precursor of carcinoma ; it is interesting to find that of 187 cases of gastric ulcer treated by a short-circuiting operation, 4 subsequently died of carcinoma of the stomach. We do not agree with the statement that the pyloric vein is not a reliable guide to the pylorus, and that to call every ulcer to the left of it 'gastric' and to the right of it 'duodenal' is to base the differentiation on an anatomical structure which is unreliable. In our experience the pyloric vein is remarkably constant in its position.

There is an especially good section on chronic obstructions of the duodenum, their cause and treatment, and attention is drawn to the fact that cases may be diagnosed as duodenal ulcers and treated by gastro-enterostomy. In several of the cases quoted this took place, and at a second operation the true state of affairs was recognized and relieved by a duodenojejunostomy. It is pointed out that the two conditions may co-exist, and that the ulceration is in all probability secondary to the obstruction, and, working from this, the suggestion that all duodenal ulcers should be treated by duodenojejunostomy is discussed, but eventually rejected.

Jejunal ulcers are not considered in any detail, which is perhaps unfortunate, as the formation of a jejunal ulcer after a gastro-enterostomy is certainly the greatest criticism of that operation.

The book is well illustrated, and is an exceedingly good and careful analysis of the gastric and duodenal cases occurring in the practices of the surgeons at the Hôtel-Dieu.

Diseases of the Gall-bladder and Bile-ducts. By Evarts Ambrose Graham, M.D., Warren Henry Cole, B.S., M.D., Glover H. Copher, M.D., and Sherwood Moore, M.D. Second printing. Large 8vo. Pp. 477 + xv, with 224 illustrations in the text and 7 plates. 1929. London : Baillière, Tindall & Cox. 35s. net.

The fact that a modern surgeon needs to be something more than a mechanic is made evident by the publication of this work, for although written by three surgeons and a radiologist, it contains the most complete account of the physiology and function of the gall-bladder and ducts that has yet been written. The need of such a work has long been felt, and that the want is now supplied is shown by the fact that the first edition was only published in 1928. Such controversial points as the methods of emptying the gall-bladder, the presence of a sphincter at the opening of the bile papilla, the possible paths of infection of the gall-bladder, and especially the value and methods of use of cholecystography, the discussions of which hitherto have had to be sought in widely scattered journals, are here considered under one cover. The opening chapters are devoted to a lucid anatomical discussion of the gall-bladder and the extrahepatic bile-ducts, and include a useful account of the many variations which are so often a source of difficulty to the practising surgeon. A detailed account of the physiology of the gall-bladder follows, and the many points which are still in doubt are carefully considered. The vast literature that has arisen around the question as to how the gall-bladder empties is carefully dissected and considered, and the authors' conclusions are stated.

The preliminary chapters are followed by a full account of cholecystitis, including the interesting condition known as the strawberry gall-bladder. The arguments in favour of the different possible paths of infection are considered at length. The varieties of gall-stones, their etiology and the methods of formation, are fully described, but it is disappointing to find that stones impacted in the intestine are stated to give symptoms similar to those due to other causes, no reference being made to Barnard's famous description of the classical symptoms. The clinical aspects of cholecystitis are well presented, with a valuable description of the less well recognized symptoms of chronic cholecystitis unassociated with calculi.

It is still accepted that, because cholecystitis is most commonly found in married women who have had children, pregnancy has had something to do with their formation, although no controlled figures have ever been published to show what proportion of women between 40 and 50 who have not got cholecystitis are married and have had children.

The chapter on icterus and cholangitis will be found of exceptional value, as this subject is but briefly discussed in the majority of text-books.

A large proportion of the volume is given over to a consideration of cholecystography, and since it comes from the pens of the introducers of the method it is at once the most complete and most authoritative account of the procedure. No one who is interested can afford to be without these sections. A curious statement is made, however, that it is doubtful if concentrated bile will give an X-ray shadow, whereas with carcinoma of the common duct the pigment calcium in the gall-bladder may be so concentrated that it may be regarded as a soft pigment calculus and may give a well-marked direct shadow of the gall-bladder. There follows another long section devoted to the consideration of the tests of liver function, which, although perhaps outside the scope of a text-book devoted to the gall-bladder and ducts, adds considerably to its value. In the remaining 60 pages there is a discussion of the surgical treatment of the lesions of the gall-bladder and ducts. This section is much less complete in detail and does not appear to have the same authoritative air as the rest of the work. The book as a whole forms a most valuable treatise which no physician, surgeon, radiologist, or clinical pathologist can afford to be without. As a presentation of valuable research work and as a comprehensive review of modern literature it is a credit to the surgery of the United States of America.

Chirurgie des Voies biliaires: Spiro-cholecystostomie. By C. SOBRE-CASAS, Chef du Service de Gynécologie de l'Hôpital Torcuato de Alvear (Buenos Aires). With a Preface by Professor J.-L. FAURE. Demy 8vo. Pp. 119, with 33 illustrations. 1928. Paris: Masson et Cie. Fr. 35.

IN the words of the preface this monograph is short, simple, and so well illustrated that the text is nearly superfluous. The story is that of fifty cases of gall-bladder disease in which cholecystectomy might appear to have been indicated, but in which, for reasons of safety, a modified operation was performed without mortality. The modified operation consists of ligature of the cystic duct and artery with: (1) Obliteration of the gall-bladder by a spiral ligature from the cystic duct to the fundus, combined with drainage (spiro-cholecystostomy); (2) Excision of the mucous membrane of the gall-bladder combined with the spiral ligature; (3) Resection of the anterior or posterior wall of the gall-bladder with curettage of the mucous surface left behind. These procedures are intended to supply a safe and yet adequate means of radical cure of gall-bladder disease.

The monograph is very beautifully illustrated with 33 coloured sketches. Such argument as is brought forward is only that of mortality; nothing is said of the quality of recovery and persistency of cure after the modified operations described. The monograph is of interest, but probably not of great utility.

Fractures and Dislocations. By PHILIP D. WILSON, A.B., M.D., F.A.C.S., Instructor in Orthopædic Surgery, Harvard Medical School; and WILLIAM A. COCHRANE, M.B., Ch.B., F.R.C.S. Edin., University Tutor in Clinical Surgery, University of Edinburgh. Second edition, revised. Medium 8vo. Pp. 789 + xvii, with 1029 illustrations. 1929. London: J. B. Lippincott Co. 45s. net.

IN the second edition of this eminently practical treatise the authors have wisely refrained from increasing its size to any material extent. Brevity and simplicity have been achieved, however, by the omission of a detailed account of many of the more important complications of fractures. Thus, ischæmic contracture, peripheral nerve and vascular injuries are dealt with somewhat scantily. On the other hand, many sections such as the chapter on spinal injuries are admirably presented.

We note that in the treatment of fractures of the lower end of the humerus, the term 'acute flexion' is still employed, and that this position is illustrated, although the dangers of maintaining contact of the forearm with the upper arm by means of strapping are duly emphasized. In the description of ankle-joint fractures the posterior marginal fracture of the tibia, known to Astley Cooper and Dupuytren, is again referred to as Cotton's fracture. In the treatment of malunited ankle fractures no mention is made of the operation of arthrodesis of the ankle. These minor blemishes do not detract from the value of this competent book, which should continue to be of great service to hospital casualty officers and young surgeons engaged in the routine of fracture treatment.

Elements of Surgical Diagnosis. By Sir ALFRED PEARCE GOULD, K.C.V.O., C.B.E., M.S., F.R.C.S., late Surgeon to the Middlesex Hospital, etc. Seventh edition, revised by ERIC PEARCE GOULD, M.D., M.Ch. Oxon., F.R.C.S. Eng., Surgeon to Out-patients at the Middlesex Hospital, Dean of the Middlesex Hospital Medical School. Pott 8vo. Pp. 730 + xv, with 26 radiographic plates. 1928. London: Cassell & Co. Ltd. 12s. 6d. net.

THE seventh edition of Pearce Gould's *Surgical Diagnosis*, appearing forty-four years after the first, proves that it has withstood the test of time, and it is too well known to require any detailed review.

The present edition differs but little from the previous ones, except in the substitution of an Introduction for the first three chapters of former editions. The increase in the value of X rays as aids to diagnosis is exemplified by mention for the first time of lipiodol, pyeloradiography, and cholecystography, but the book impresses on the student throughout that, despite the advances in scientific medicine, bedside diagnosis by the eye and hand forms the basis of correct surgical diagnosis.

Whether as a book of reference or for systematic reading, we can recommend it to the student, and in it he will find the very fundamentals which will enable him to avoid many of the pitfalls of the examination room.

Surgical Radiology. By A. P. BERTWISTLE, F.R.C.S., late Resident Surgical Officer, General Infirmary, Leeds. With an Introduction by D. P. D. WILKIE, O.B.E., F.R.C.S., Professor of Surgery, University of Edinburgh. Post 8vo. Pp. 142 + xi. Illustrated. 1929. London: J. & A. Churchill. 8s. 6d. net.

THIS is a small book of about 140 pages, having ten sections dealing in a very brief way with the usual text-book physiological systems. It is described by the author as " written to meet the demand for a book on the interpretation of radiograms ", and " from the clinical point of view ", but the preface does not state whether it is designed to supplement the already long list of medical 'Aids' series for students. From its title one would expect great things, but after a careful perusal one can only quote Horace's famous line, *Parturiunt montes* . . . , etc. The 21 illustrations are good.

Handbook of Anæsthetics. By J. STUART ROSS, M.B., Ch.B., F.R.C.S.E., late Lecturer in Practical Anæsthetics, University of Edinburgh; and H. P. FAIRLIE, M.D., Anæsthetist to the Western Infirmary and the Royal Hospital for Sick Children, Glasgow. Third edition. Crown 8vo. Pp. 339 + xvi. Illustrated. 1929. Edinburgh: E. & S. Livingstone. 8s. 6d. net.

No one acquainted with Ross's small handbook will be surprised to see a third edition making its appearance within three years of the first. The book has grown considerably, but the authors have succeeded in maintaining the practical nature of the work, and in their attempt to keep abreast of modern teaching and practice they have shown great discretion in their choice of new material. One of the most valuable chapters is that dealing with nitrous-oxide anæsthesia, with its lucid description of the technique of administration.

Where only limited space is available care has been taken that details essential to safety shall not be omitted, a good example occurring in the case of ether-oil anæsthesia, where the advice is given to be content with a 50 per cent instead of a 75 per cent solution, and an incomplete rectal, supplemented by slight inhalation, anæsthesia.

Mr. Wood, in re-editing the section on local analgesia, has dealt with his subject in the same clinical manner so characteristic of the whole of this attractive little book.

The Pressure Pulses in the Cardiovascular System. By C. J. WIGGERS, M.D., Professor of Physiology in the School of Medicine of Western Reserve University, Cleveland, Ohio. Demy 8vo. Pp. 200 + xi. Illustrated. 1928. London: Longmans, Green & Co. 14s. net.

THIS book, whose author is a well-known professor of physiology in America, is one of a series of monographs on physiology. It is concerned with the methods of measurement of the endocardiac pressure, and the interpretation of the records. The author's procedure is to insert a cannula into the ventricle through its wall, or into the auricle through a vein. The cannula is led off to a manometer with a rubber dam bearing a mirror, the movements of which are recorded by reflected light. Dogs are generally used, and artificial respiration is necessary. One outstanding result is the demonstration that the intraventricular pressure is never below zero. This probably accounts for the fact that we no longer stand in dread of serious trouble from air entering the heart through cut veins during an operation on the neck. The differences in type between the subclavian, radial, and femoral pulses in man are figured and discussed. The larger arteries are capable of undergoing local tonic contractions. The book may be warmly commended to those surgeons who retain an interest in the physiological problems of the heart even when the clinical application is not immediately obvious.

The Blood Plasma in Health and Disease. By J. W. PICKERING, D.Sc. Lond., Lecturer on Hæmatology, University of London, King's College. Monographs of Medical and Surgical Science. Demy 8vo. Pp. 247 + xi. 1928. London: William Heinemann (Medical Books) Ltd. 12s. 6d. net.

THIS book contains an excellent review of the modern work on coagulation of the blood and the diseases in which it is altered. The author, who has made this field his special study, has not only discussed the literature of the subject, including his own work, but has made many stimulating suggestions to point the way for further research. Points of clinical importance receive their due attention. The book is of value to physiologist, physician, and surgeon alike.

The Tonsils and Adenoids and their Diseases: Including the Part they play in Systemic Diseases. By IRWIN MOORE, M.B., C.M. (Edin.), late Honorary Surgeon to the London Throat Hospital and Metropolitan Hospital for Diseases of the Throat, Nose and Ear, Great Portland Street. Demy 8vo. Pp. 395 + xix, illustrated. 1928. London: William Heinemann. 21s. net.

THE author has set himself the task of concentrating that which is of importance from the enormous mass of periodical literature relating to tonsils and their diseases. The appearance of such a work is timely, and, although Irwin Moore has himself in the past published a number of papers on the subject, he has succeeded in giving a reasoned statement without undue personal bias. The book is readable, and its value is much enhanced by the number of references to the literature which it contains. In addition to the details of operative technique, the anatomy and pathology of the tonsils are fully dealt with, while the chapter devoted to treatment in cases in which surgical removal is contra-indicated should be particularly useful. The nasopharyngeal and lingual tonsils have each a chapter devoted to themselves, and, under the former, the inclusion of a description of breathing exercises to be used after operation is both an unusual and acceptable feature.